TAXONOMY

A REVISION OF THE GENUS *ELAMPUS* SPINOLA *(NOTOZUS* AUCTT.) (HYMENOPTERA: CHRYSIDIDAE) IN AMERICA NORTH OF MEXICO[1]

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Abstract

The genus *Elampus* Spinola (Hymenoptera: Chrysididae) in America north of Mexico is revised. Seven species and one subspecies are included. These are *E. hyalinus* (Aaron), *E. rotundus* Huber sp. nov., *E. nitidus nitidus* (Aaron), *E. nitidus californicus* Huber subsp. nov., *E. viridicyaneus* Norton, *E. marginatus* (Patton), *E. aaroni* Bodenstein, and *E. versicolor* Norton. *E. versicolor* is considered as a species of uncertain status. *E. connexus* (Viereck) and *E. mexicanus Mocsáry* are synonomized under *E. viridicyaneus* and *E. nitidus nitidus* respectively. All available types were examined. A neotype is designated for *E. marginatus*. The holotypes of *E. viridicyaneus* and *E. versicolor* were examined but, subsequently, were lost in the mail. A few possible, additional species were segregated but are not described or named herein.

A discussion of diagnostic characters for North American species and a short historical review is presented. Discriminant analysis of eighteen measurements and ratios for the first six of the above mentioned taxa was undertaken and gave quantitative characters useful for species distinction. Information on the biology of *Elampus* is summarized on a world basis. Intraspecific variation is discussed in detail under each species.

Introduction

Historical Review

The genus *Elampus* consists of about 40 species (Bischoff, 1913) distributed throughout the Western Hemisphere and the Palaearctic and Ethiopian regions. It has been studied relatively little and most studies on *Elampus* form part of more inclusive studies dealing with the whole family for various geographical areas. The only paper dealing exclusively with *Elampus* (as *Notozus)* was by Móczár (1964). Most of the literature on the family and, consequently, the genus deals with the European fauna. Major, relatively recent, works for Europe are by Trautmann (1927) and Linsenmaier (1951). Smaller geographical areas were treated by Trautmann (1930) (North and Central Europe); Berland and Bernard (1938) (France); Atanassov (1940) (Bulgaria); Benno (1950) (Holland); Balthasar (1954) (Czechoslovakia); Haupt (1956) (Central Europe); Noskiewicz and Pulawski (1958) (Poland) and Móczár (1964, 1967) (Hungary). Relatively few papers containing information on *Elampus* were published for areas other than Europe. Important ones are: Tosawa (1931) (Japan); Edney (1940) (Southern Africa); Balthasar (1951) (Palestine and surrounding areas); Tsuneki (1954) (Manchuria); Linsenmaier (1959, 1968) (Palaearctic region) and Semenov-Tian-

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Shanskij (1967) (USSR). Zimmermann (1961) described a new species of *Notozus* from Madagascar. Ducke (1913) catalogued the Brazilian Chrysididae. A world revision and two catalogues of the family were provided by Mocsáry (1889), Dalla Torre (1892), and Bischoff (1913), respectively.

The literature on *Elampus* for North America consists essentially of a number of descriptions of new species of *Elampus (Notozus)* and a revision of the family Chrysididae by Aaron (1885). Apart from a catalogue of the North American species of Chrysididae by Bodenstein (1951) and a very few papers which include some reference to species of *Elampus* (e.g. Krombein, 1963; Kurczewski, 1970) virtually nothing has been published on North American *Elampus* since Aaron's revision. This is the first revision of *Elampus* for North America since 1885.

Nomenclature and Generic Relationships

Two names, *Elampus* and *Notozus,* have been used for the genus. The name *Elampus* has priority but the name *Notozus* has been used more extensively. In general, old world authors have used the name *Notozus* whereas North Americans have used the name *Elampus*. The name *Elampus* has also been used for the related genus *Omalus* Panzer (e.g. Taschenberg, 1866; Aaron, 1885; Buysson, 1891; Bischoff, 1913; Berland and Bernard, 1938; Semenov-Tian-Shanskij, 1967). A discussion of the use of the two names and a plea for the suppression of *Elampus* and the addition of *Notozus* to the Official List of Generic Names was given by Huber (1975). In this paper the name *Elampus* is used pending a decision by the International Commission on Zoological Nomenclature.

The genus *Elampus* is most closely related to the genus *Omalus*. Bohart and Campos (1960) listed several characters common to both genera. The occurrence of species having character combinations or characteristics apparently intermediate between the two genera led Linsenmaier (1959, 1968) to treat *Elampus (Notozus)* as a subgenus of *Omalus*. Peters (1966) discussed the separation of the two genera and noted that no single character was sufficient to separate all species but that a combination of characters was necessary. He considered that *Elampus (Notozus)* and *Omalus* should be kept as separate genera. Radoszkowski (1889) and Lorencowa (1962, 1966) considered the male genitalia and the hidden abdominal segments of females, respectively, of *Elampus* and *Omalus* to be sufficiently distinct to keep them as separate genera. In the present paper *Elampus* is considered distinct from *Omalus* on the basis of differences in genitalia, the presence of *Elampus* and the absence in *Omalus* of distinct secondary sexual characters, and differences in biology based on the scanty biological evidence available.

Biology

Very little is known about the host-parasite relationships of *Elampus*. From the few available records it appears that species of *Elampus* parasitize soil-nesting sphecids. Spooner (1948) gave a fairly complete account of parasitism of *Mimesa* by *Elampus,* summarizing records by Morice (1903), Bischoff (1913), Trautmann (1927), and Berland and Bernard (1938). Bohart (1976) brought the nomenclature of the species of *Mimesa* up to date and, quoting Móczár (1967), lists the following species of *Elampus* as parasites of *Mimesa: Elampus panzeri* (F.) on *M. equestris* (as *Psen bicolor* Shuckard); *E. constrictus* (Foerster) on *M. bicolor* and *M. lutaria* (as *Psen shuckardi* Westmael). In addition, Spooner listed *Elampus spina* (Lepeletier) as a parasite of *M. lutaria* in Sweden.

In North America the only published host record is of *Elampus viridicyaneus* parasitizing *Psammecius costalis* (Cresson) (Krombein, 1958, 1963). Negative, circumstantial evidence indicates that species of *Elampus* in North America parasitize soil-nesting rather than twig-nesting wasps. For example, of several trap-nesting studies undertaken (Medlar, 1964; Krombein, 1967) no *Elampus* were reared authough species of *Omalus* and other Chrysididae were reared relatively often from their twig-nesting hosts. Many of the pinned specimens of *Elampus* examined in the present study had sand grains firmly stuck in the coarser punctures of the body or on the apical truncation suggesting that the wasps had been burrowing in sandy soil.

The habits of *Elampus* are poorly known. Collection records indicate that adults are often caught on flowers. Buysson (1891) mentioned that species of *Elampus (Notozus)* were attracted to the sweet secretions on leaves and Balthasar (1954) noted that they were attracted to honeydew and could be caught most readily in dry areas. Kurczewski (1970) collected *E. maginatus* and *E. viridicyaneus* on gravel and sand at the edges of woodlands.

Nothing is known about the life cycle or immature stages of *Elampus*. Krom-*bein* (1963) suggested that *E. viridicyaneus* was multivoltine in Maryland.

Materials and Methods

Approximately 2,300 pinned specimens of North American *Elampus* were examined. Material for this study was borrowed from a number of institutions. Institutions in which type material is deposited are followed by their abbreviations. The assistance of the curators responsible for the loan of the specimens from their respective institutions is gratefully acknowledged. Academy of Natural Sciences, Philadelphia (ANSP) (W. W. Moss); American Museum of Natural History, New York (AMNH) (M. Favreau); Biosystematics Research Institute, Ottawa (BRI) (C. Yoshimoto); California Academy of Sciences, San Francisco (CAS) (T. J. Zavortink); California Insect Survey, University of California, Berkeley (CIS) (H. V. Daly); Connecticut Agriculture Experimental Station, New Haven (K. A. Welch); Cornell University, Cornell (CORN) (L. L. Pechuman); Field Museum of Natural History, Chicago (J. B. Kethley); Florida Department of Agriculture, Division of Plant Industry, Gainesville (E. E. Grissel); K. V. Krombein Personal Collection, Washington, D.C.; W. Linsenmaier Personal Collection, Ebikon, Switzerland (LINS); Lyman Entomological Museum, Macdonald College, Ste. Anne de Bellevue (V. R. Vickery); Michigan State University, East Lansing (MSU) (R. L. Fischer); Museum of Comparative Zoology, Harvard University, Cambridge (J. F. Lawrence); Museum D'Histoire Naturelle, Geneva, Switzerland (MNHG) (C. Besuchet); North Carolina State University, Raleigh (D. A Young); Northern Arizona University, Flagstaff (C. D. Johnston); Royal Ontario Museum, Toronto (G. B. Wiggins); Strickland Museum, University of Alberta, Edmonton (G. E. Ball); United States National Museum, Washington, D.C. (USNM) (K. V. Krombein); University of British Columbia, Vancouver (G. G. E. Scudder); University of California, Davis (UCD) (R. M. Bohart); University of California, Riverside (UCR) (S. Frommer); University of Kansas (Snow Collection), Lawrence (G. W. Byers); Washington State University, Pullman (W. J. Turner). Type material was seen unless otherwise indicated.

Measurements were made on a representative sample (usually 10 males and 10 females of six taxa using a standard 400 square ocular reticule. A given structure was measured under the highest magnification possible with the structure completely visible within the area of the reticule. The measurements made, with the abbreviations used in the Figures 10-13 and Tables I, II, and III are as follows: length and width of head (LH and WH respectively); width of face (WF);

TABLE I. Measurements (in mm) and ratios for the type specimens of North American *Elampus* species (Hymenoptera, Chrysididae).

Species	*Elampus nitidus nitidus* (holotype)	*E. mexicanus* (lectotype)	*E. nitidus californicus* (holotype)	*E. viridicyaneus* (holotype)	*E. connexus* (holotype)	*E. versicolor* (holotype)	*E. marginatus* (neotype)	*E. hyalinus* (paratype)	*E. aaroni* (=*productus*) (paratype)	*E. rotundus* (holotype)
Sex	♂	♂	♂	♂	♂	♂	♀	♀	♂	♂
Type no.	4910	83	4910	4920	914	4921	N.A.	4912	4913	N.A.
TL (Var. 1)	5.8	5.1	4.5	7.1	7.0	6.2	4.8	5.6	5.3	4.4
$\frac{WH}{LH}$ (Var. 3)	$\frac{1.35}{0.62}=2.19$	$\frac{1.32}{0.53}=2.50$	$\frac{1.28}{0.59}=2.15$	$\frac{1.85}{0.70}=2.63$	$\frac{1.94}{0.70}=2.75$	$\frac{1.65}{0.64}=2.59$	$\frac{1.21}{0.46}=2.63$	$\frac{1.50}{0.66}=2.27$	$\frac{1.43}{0.57}=2.50$	$\frac{1.19}{0.48}=2.45$
$\frac{WP}{LP}$ (Var. 2)	$\frac{1.23}{0.66}=1.87$	$\frac{1.17}{0.62}=1.27$	$\frac{1.10}{0.57}=1.92$	$\frac{1.72}{0.79}=2.15$	$\frac{1.85}{0.86}=2.15$	$\frac{1.54}{0.70}=2.19$	$\frac{1.14}{0.66}=1.73$	$\frac{1.45}{0.75}=1.97$	$\frac{1.28}{0.66}=1.93$	$\frac{1.06}{0.59}=1.78$
$\frac{W_I}{L_I}$ (Var. 4)	$\frac{1.58}{0.52}=3.06$	$\frac{1.09}{0.59}=2.06$	$\frac{1.41}{0.48}=2.91$	$\frac{2.33}{0.70}=3.31$	$\frac{2.51}{0.79}=3.17$	$\frac{1.88}{0.70}=2.67$	—	$\frac{1.67}{0.55}=3.04$	$\frac{1.56}{0.62}=2.54$	$\frac{1.32}{0.40}=3.33$
$\frac{W_{II}}{L_{II}}$ (Var. 5)	$\frac{1.63}{1.14}=1.42$	$\frac{1.67}{1.17}=1.43$	$\frac{1.52}{1.06}=1.44$	$\frac{2.38}{1.58}=1.50$	$\frac{2.60}{1.81}=1.43$	$\frac{1.94}{1.41}=1.38$	$\frac{1.43}{1.08}=1.32$	$\frac{1.80}{1.23}=1.32$	$\frac{1.60}{1.14}=1.39$	$\frac{1.41}{0.97}=1.45$
$\frac{L_{III}}{W_{III}}$ (Var. 6)	$\frac{1.36}{0.80}=1.71$	$\frac{1.41}{1.14}=1.23$	$\frac{1.30}{0.79}=1.64$	$\frac{2.05}{1.06}=1.95$	$\frac{2.02}{1.23}=1.64$	$\frac{1.50}{0.97}=1.55$	$\frac{1.32}{1.14}=1.16$	$\frac{1.63}{1.23}=1.32$	$\frac{1.23}{0.85}=1.45$	$\frac{1.23}{0.76}=1.62$
$\frac{W_t}{H_t}$ (Var. 7)	$\frac{0.30}{0.22}=1.36$	$\frac{0.35}{0.26}=1.33$	$\frac{0.24}{0.18}=1.38$	$\frac{0.53}{0.32}=1.51$	$\frac{0.53}{0.32}=1.51$	$\frac{0.51}{0.35}=1.44$	$\frac{0.31}{0.21}=1.48$	$\frac{0.33}{0.29}=1.26$	$\frac{0.46}{0.29}=1.58$	$\frac{0.26}{0.28}=0.92$
$\frac{H_t}{H_l}$ (Var. 8)	$\frac{0.22}{0.04}=6.06$	$\frac{0.26}{0.04}=6.00$	$\frac{0.18}{0.04}=4.00$	$\frac{0.35}{0.15}=2.41$	$\frac{0.32}{0.08}=4.18$	$\frac{0.35}{0.11}=3.22$	$\frac{0.21}{0.07}=3.00$	$\frac{0.29}{0.09}=3.00$	$\frac{0.29}{0.07}=4.44$	$\frac{0.26}{0.01}=24$
$\frac{W_t}{W_{III}}$ (Var. 10)	$\frac{0.30}{1.36}=0.22$	$\frac{0.35}{1.41}=0.25$	$\frac{0.24}{1.30}=0.19$	$\frac{0.51}{2.05}=0.26$	$\frac{0.53}{2.02}=0.26$	$\frac{0.51}{1.50}=0.34$	$\frac{0.31}{1.32}=0.23$	$\frac{0.33}{1.63}=0.20$	$\frac{0.46}{1.23}=0.38$	$\frac{0.26}{1.23}=0.21$

Species	*Elampus nitidus nitidus* (holotype)	*E. mexicanus* (lectotype)	*E. nitidus californicus* (holotype)	*E. viridicyaneus* (holotype)	*E. connexus* (holotype)	*E. versicolor* (holotype)	*E. marginatus* (neotype)	*E. hyalinus* (paratype)	*E. aaroni* (=*productus*) (paratype)	*E. rotundus* (holotype)
Sex	♂	♂	♂	♂	♂	♂	♀	♀	♂	♂
L_F (Var. 11)	3.8	3.6	3.3	4.9	5.2	—	3.4	—	4.2	3.2
ST (Var. 16)	1.50	1.50	1.32	—	2.11	—	1.41	—	1.72	1.26
L_{RS} (Var. 12)	0.26	0.26	0.22	0.40	0.40	0.36	0.24	0.22	0.26	0.13
L_S (Var. 13)	0.31	0.31	0.24	0.35	0.40	0.35	0.26	0.26	0.32	0.26
$\frac{F_I}{F_{II}}$ (Var. 9)	$\frac{0.26}{0.18}=1.50$	$\frac{0.26}{0.18}=1.50$	$\frac{0.22}{0.15}=1.43$	$\frac{0.37}{0.26}=1.43$	$\frac{0.40}{0.24}=1.64$	$\frac{0.35}{0.24}=1.46$	$\frac{0.31}{0.11}=2.82$	$\frac{0.22}{0.11}=2.00$	$\frac{0.31}{0.18}=1.75$	$\frac{0.22}{0.14}=1.43$
SD (Var. 17)	0.44	0.48	0.44	0.62	0.65	0.62	0.44	0.53	0.50	0.39
WF (Var. 14)	0.86	0.84	0.79	1.08	1.19	1.03	0.84	0.92	0.92	0.77
LF (Var. 15)	0.91	0.92	0.88	1.14	1.19	1.19	—	1.03	1.07	0.81
LID (Var. 18)	0.26	0.24	0.26	0.31	0.35	0.39	0.24	0.33	0.29	0.26
OOD (Var. 19)	0.31	0.31	0.26	0.42	0.40	0.51	0.31	0.26	0.35	0.23

Abbreviations: TL = total length; $\frac{WH}{LH}$ = width/length of head; $\frac{WP}{LP}$ = width/length of pronotum; $\frac{W_I}{L_I}$, $\frac{W_{II}}{L_{II}}$, $\frac{W_{III}}{L_{III}}$ = width/length of first, second and third tergite, respectively; $\frac{W_t}{H_t}$ = width/height of apical truncation; $\frac{H_t}{H_i}$ = height of truncation/height of incision; $\frac{W_t}{W_{II}}$ = width of truncation/width of third tergite; L_F = length of forewing; ST = length of forewing from stigma to wing tip; L_{RS} = length of radial sector; L_S = length of stigma; $\frac{F_I}{F_{II}}$ = length of first flagellomere/second flagellomere; SD = length of scape; WF = width of face; LF = length of face; LID = least interocellar distance; OOD = ocellocular distance; N.A. = not available.

TABLE II. Means and standard deviations for ratios and measurements (in mm) of males and females of eight taxa of North American *Elampus* (Hymenoptera, Chrysididae).

Species		*E. nitidus nitidus*[1]		*E. nitidus*[1] *californicus*		*E. viridi-cyaneus*[1]		*E. marginatus*[1] (green-black form)		*E. hyalinus*[1]		*E. rotundus*[1]		*E. aaroni*[3]	*E. versicolor*[2,3]
Sex		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♀	♀
n		15	20	10	10	10	10	10	10	10	25	6	9	3	1
TL	m	5.0	5.1	4.6	4.7	7.2	7.7	5.8	5.7	4.6	4.7	4.6	5.0	5.7	5.8
	S.D.	0.6	0.5	0.3	0.5	0.3	0.4	0.7	0.4	0.6	0.5	0.3	0.7	0.5	—
WH/LH	m	2.37	2.51	2.21	2.32	2.71	2.73	2.44	2.66	2.38	2.42	2.44	2.43	2.78	$\frac{1.45}{0.55}=2.61$
	S.D.	0.15	0.24	0.11	0.09	0.26	0.12	0.09	0.14	0.13	0.12	0.05	0.12	0.10	
WP/LP	m	1.87	1.71	1.87	1.75	2.08	1.88	1.86	1.66	1.91	1.86	1.93	1.80	1.69	$\frac{1.28}{0.70}=1.81$
	S.D.	0.08	0.09	0.07	0.11	0.12	0.10	0.09	0.04	0.09	0.07	0.21	0.11	0.03	
W_{II}/L_{II}	m	1.45	1.41	1.40	1.38	1.52	1.44	1.46	1.38	1.52	1.51	1.45	1.50	1.35	$\frac{1.67}{1.28}=1.31$
	S.D.	0.07	0.05	0.05	0.08	0.06	0.05	0.07	0.02	0.07	0.07	0.02	0.06	0.02	
W_{III}/L_{III}	m	1.61	1.46	1.57	1.48	2.00	1.71	1.58	1.42	1.30	1.31	1.66	1.44	1.32	$\frac{1.32}{0.77}=1.71$
	S.D.	0.20	0.30	0.18	0.24	0.39	0.20	0.16	0.19	0.10	0.13	0.09	0.19	0.05	
W_t/H_t	m	1.48	1.35	1.51	1.41	1.80	1.82	1.43	1.33	1.26	1.15	1.00	0.98	1.47	$\frac{0.44}{0.31}=1.43$
	S.D.	0.23	0.24	0.16	0.28	0.17	0.30	0.11	0.10	0.18	0.10	0.07	0.09	0.05	
H_t/H_i	m	4.13	3.21	3.74	3.51	2.69	1.72	3.88	3.28	6.74	4.87	23.3	18.2	3.53	$\frac{0.31}{0.09}=3.50$
	S.D.	1.46	1.26	0.67	0.70	0.62	0.26	0.94	1.20	2.91	1.28	8.0	16.0	0.41	
W_t/W_{III}	m	0.25	0.22	0.22	0.21	0.24	0.26	0.26	0.23	0.25	0.23	0.24	0.21	0.34	$\frac{0.44}{1.32}=0.33$
	S.D.	0.03	0.04	0.03	0.03	0.04	0.05	0.04	0.03	0.03	0.02	0.02	0.03	0.03	
L_F	m	3.7	3.6	3.1	3.2	5.5	5.8	4.1	4.1	3.3	3.5	3.2	3.7	4.4	4.7
	S.D.	0.5	0.3	0.3	0.2	0.3	0.4	0.5	0.4	0.3	0.3	0.3	0.4	0.2	
L_{RS}	m	0.25	0.25	0.21	0.22	0.42	0.47	0.31	0.30	0.21	0.22	0.16	0.18	0.31	0.35
	S.D.	0.05	0.03	0.03	0.03	0.06	0.04	0.06	0.04	0.03	0.03	0.02	0.02	0.04	
L_S	m	0.28	0.26	0.25	0.25	0.42	0.44	0.35	0.29	0.26	0.27	0.27	0.27	0.33	0.40
	S.D.	0.04	0.03	0.02	0.02	0.06	0.06	0.06	0.02	0.02	0.02	0.02	0.03	0.03	

Species		*E. nitidus*[1] *nitidus*[1]		*E. nitidus californicus*		*E. viridicyaneus*[1]		*E. marginatus*[1] (green-black form)		*E. hyalinus*[1]		*E. rotundus*[1]		*E. aaroni*[3]	*E. versicolor*[2,3]
Sex		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♀	♀
$\frac{F_I}{F_{II}}$	m	1.53	1.82	1.47	1.68	1.57	1.66	1.52	1.80	1.58	1.82	1.47	1.73	1.81	$\frac{0.35}{0.19}=1.88$
	S.D.	0.11	0.27	0.12	0.12	0.14	0.36	0.14	0.15	0.18	0.34	0.04	0.19	0.04	
SD	m	0.49	0.52	0.43	0.48	0.66	0.82	0.53	0.57	0.38	0.40	0.39	0.45	0.58	0.57
	S.D.	0.05	0.05	0.03	0.03	0.06	0.03	0.07	0.06	0.04	0.05	0.05	0.05	0.02	
WF	m	0.85	0.86	0.80	0.84	1.15	1.25	0.93	0.97	0.73	0.82	0.79	0.87	0.96	1.03
	S.D.	0.09	0.07	0.05	0.07	0.06	0.05	0.12	0.05	0.06	0.07	0.06	0.11	0.09	
LF	m	0.94	0.98	0.86	0.93	1.20	1.37	1.02	1.04	0.84	0.90	0.81	0.91	1.12	1.08
	S.D.	0.08	0.06	0.06	0.06	0.05	0.05	0.09	0.11	0.07	0.07	0.06	0.11	0.11	
LID	m	0.28	0.26	0.25	0.26	0.31	0.33	0.27	0.27	0.27	0.28	0.28	0.30	0.30	0.25
	S.D.	0.03	0.02	0.02	0.02	0.03	0.02	0.03	0.03	0.03	0.03	0.02	0.04	0.03	
OOD	m	0.31	0.31	0.28	0.29	0.42	0.46	0.34	0.34	0.22	0.24	0.24	0.26	0.38	0.40
	S.D.	0.03	0.03	0.02	0.02	0.02	0.02	0.04	0.04	0.03	0.02	0.02	0.03	0.02	
MOD	m	0.097	0.095	0.088	0.092	0.138	0.142	0.098	0.097	0.098	0.096	0.095	0.095	0.098	0.114
	S.D.	0.011	0.009	0.007	0.007	0.010	0.011	0.007	0.005	0.005	0.007	0.007	0.016	—	

[1] Measurements for these taxa used for discriminant analysis.
[2] Measurements and ratios only are given (n = 1).
[3] Not included in discriminant analysis.

Abbreviations: n = number of specimens measured; TL = total length; $\frac{WH}{LH}$ = width/length of head; $\frac{WP}{LP}$ = width/length of pronotum; $\frac{W_I}{L_I}$, $\frac{W_{II}}{L_{II}}$, $\frac{W_{III}}{L_{III}}$ = width/length of first, second and third tergite, respectively; $\frac{W_t}{H_t}$ = width/height of apical truncation; $\frac{H_t}{H_i}$ = height of truncation/height of incision; $\frac{W_t}{W_{III}}$ = width of truncation/width of third tergite; L_F = length of forewing; ST = length of forewing from stigma to apex; L_{RS} = length of radial sector; L_S = length of stigma; $\frac{F_I}{F_{II}}$ = length of first flagellomere/length of second flagellomere; SD = length of scape; WF = width of face; LF = length of face; LID = least interocellar distance; OOD = ocellocular distance; MOD = midocellus diameter; m = mean; S.D. = standard deviation.

TABLE III. Results of Scheffé's multiple range test on six taxa of North American *Elampus* (Hymenoptera, Chrysididae)[a].

Variable	Scheffé at 0.01 level of significance[b,c,d]					
Total length (TL) (Variable 1)	1	2	5	4	3	6
$\frac{\text{Width}}{\text{Length}}$ of tergite II ($\frac{W_{II}}{L_{II}}$) (Variable 5)	1	3	4	6	5	2
$\frac{\text{Width}}{\text{Length}}$ of tergite III ($\frac{W_{III}}{L_{III}}$) (Variable 6)	2	3	1	5	4	6
$\frac{\text{Width}}{\text{Height}}$ of apical truncation ($\frac{W_t}{H_t}$) (Variable 7)	5	2	3	4	1	6
$\frac{\text{Height of truncation}}{\text{Height of incision}}$ ($\frac{H_t}{H_i}$) (Variable 8)	6	3	1	4	2	5
Length of forewing (L_F) (Variable 11)	5	1	2	4	3	6
Length of radial sector (L_{RS}) (Variable 12)	5	1	2	4	3	6
Width of face (WF) (Variable 14)	2	1	5	4	3	6
Length from stigma tip to wing tip (ST) (Variable 16)	1	5	2	4	3	6
Least interocellar distance (LID) (Variable 18)	1	4	2	3	5	6
Ocellocular distance (OOD) (Variable 19)	1	4	2	3	5	6

[a] Summarized from a computer printout (available at University of Guelph, Department of Environmental Biology).
[b] Means ranked in ascending order.
[c] 1 = *Elampus nitidus californicus*, 2 = *E. hyalinus*, 3 = *E. marginatus*, 4 = *E. nitidus nitidus*, 5 = *E. rotundus*, 6 = *E. viridicyaneus*.
[d] Lines connecting taxa indicate no significant difference among taxa means.

midocellus width (MOD); least interocellar distance (LID): ocellocular distance (OOD); length of scape (SD); length of first and second flagellomeres (F_I, F_{II}); length and width of pronotum (LP and WP respectively); lengths and widths of tergites I, II, III, (L_I, L_{II}, L_{III}, W_I, W_{II}, W_{III}, respectively); width of apical truncation (W_A); height of incision (H_i); length of forewing (L_F); length of stigma (L_S); length of radial sector (L_{RS}). A number of measurements were used in the form of ratios. Body length was measured in three parts as follows: maximum length of head (with face vertical); length of thorax from anterior margin of pronotum to apex of postscutellar blade measured in side view or from above when both extremes were in focus; length of abdomen from propodeum to apex of snout-like projection measured in side view. The three measurements combined were used for total length (TL).

Using the Statistical Package for the Social Sciences (SPSSH) — version 6.01 at the University of Guelph, the following statistical analyses were performed on 16 variables (Table I):

1. discriminant analysis, treating six taxa without regard to sex and the two sexes without regard to taxon;
2. two-way ANOVA on each variable, testing for the main effects of sex and taxon and interaction between sex and taxon;
3. one-way ANOVA treating the six taxa as six groups without regard to sex.

The one-way ANOVAs were used to perform Scheffé's multiple range test for variables which were highly significant for species only (as determined by the two-way ANOVAs) since the SPSSH package had no multiple range test option for significant factors in the two-way ANOVA. Because no program at the University of Guelph could perform discriminant analysis using individuals with missing observations, variable 4 ($\frac{W_I}{L_I}$) was removed since it had the most missing observations. Any further individuals with missing variables were ignored in the analysis.

Puncture size and density were described as follows: large punctures — diameter equal to or larger than the width of midocellus; medium punctures — about 0.5 times the width of midocellus; small punctures — about 0.25 times the width of midocellus; minute punctures — very small punctures, diameter not greater than depth; contiguous punctation — punctures touching each other; dense punctation — punctures less than one puncture-width apart but not touching; moderate punctation — punctures one to two puncture-widths apart; sparse punctation — punctures greater than two puncture-widths apart.

Male genitalia and the hidden tergites and sternites of the ovipositor tube of females were dissected from relaxed specimens, cleared in hot, dilute, sodium-hydroxide solution, washed in distilled water, and mounted in Hoyer's medium for microscopic examination. The lengths of a digitus, cuspis, and paramere were measured at 100X magnification using an ocular micrometer. The lengths of the digitus and cuspis were measured from their junction, and the paramere length from its junction with the gonobase (Fig. 14). The measurements were expressed as ratios of digitus to cuspis (d/c) and cuspis to paramere (c/p) lengths, respectively. Measurements are given in Table IV. Terminology of parts of the hidden tergites and sternites of females follows that of Lorencowa (1962).

Scanning electron micrographs were taken using specimens coated with 300A gold/palladium at 5 or 10 kv in an ETEC Autoscan scanning electron microscope.

Taxonomic Characters

The amount of variation within species of *Elampus* was considerable. Diagnostic, species characters were few and often variable. A few species, e.g., *E. hyalinus* and *E. rotundus* sp. nov., were easily recognizable and one or two diagnostic characters were sufficient to distinguish all specimens accurately. Others, e.g., *E. marginatus* and *E. aaroni* were relatively difficult to distinguish and the extremes of one species appeared to intergrade with the extremes of another species so that it was impossible to determine confidently every specimen to species, although if a number of characters were considered most specimens could be identified with certainty.

Body colour was the most conspicuous character in the genus. Within a given species, however, it was extremely variable and some species, e.g., *E. marginatus* were polychromic, having several different colour forms. Once the colour variations were known they were an important aid to identification in some species. Telford (1964) and Horning (1969) discussed the possible reasons for colour variation. Frey (1936), Berland and Bernard (1938), and Balthasar (1954) discussed in detail colour and its formation in Chrysididae. Wing colour was important in distinguishing one species *viz., E. hyalinus.*

Punctation was similar in all species. Within a species, the density of punctation on a particular sclerite sometimes varied considerably, especially on the thorax and abdomen. In some species, e.g., *E. marginatus* and *E. nitidus nitidus* specimens from the southern part of the range had denser punctation than did specimens from the northern part of the range. Buysson (1908) seemed to suggest this for *Notozus productus* Dahlbom in Egypt and Horning (1969) noted this for *Chrysura sonorensis* (Cameron) in North America.

On the head, the major qualitative character, useful for distinguishing species, was the nature of the scapal basin which varied from smooth or somewhat rugose to finely, evenly, and distinctly striate depending on the species. No useful taxonomic characters were found on the thorax. The pattern of ridges on the propodeum was complex but there did not appear to be any significant differences among species. The number of teeth in the tarsal claws was very important in distinguishing certain species although within a species there was some variation.

Most specific characters were found on the abdomen. The colour and shape of the abdomen and, in particular, the shape of the third tergite and apical truncation were very important in spite of a certain amount of intraspecific variation. No consistent differences were found in the shape of the hidden abdominal segments of females but more study of this character is needed. Lorencowa (1966) found useful taxonomic characters in the hidden segments of *Hedychrum*. In the male genitalia, differences were found in the relative lengths of the digiti, cuspides, and parameres of some species (Table IV).

TABLE IV. Ratios of lengths of digitus/cuspis and cuspis/paramere of male genitalia of North American *Elampus* species (Hymenoptera, Chrysididae).

Species	n	$\frac{d}{c}$		$\frac{c}{p}$	
		m	S.D.	m	S.D.
Elampus nitidus nitidus	4	0.58	0.05	0.61	0.04
Elampus nitidus californicus	1	0.57	—	0.62	—
Elampus hyalinus	4	0.61	0.06	0.50	0.03
Elampus viridicyaneus	15	0.62	0.03	0.64	0.03
Elampus marginatus	23	0.62	0.04	0.62	0.04
Elampus versicolor (?) (ex Bard, California)	1	0.52	—	0.64	—
Elampus aaroni (paratype)	1	0.59	—	0.66	—
Elampus rotundus	2	0.58	0.02	0.52	0.02
Elampus mexicanus (paratype)	1	0.64	—	0.61	—

Abbreviations: n = number of genitalia measured; m = mean; S.D. = standard deviation; $\frac{d}{c}$ = digitus length/cuspis length; $\frac{c}{p}$ = cuspis length/paramere length.

TABLE V. Summary of highly correlated variables for North American *Elampus* (Hymenoptera, Chrysididae) (from statistical analyses of 18 variables and six taxa)[a].

Character	Above 80% correlation	Above 70% correlation
Total length (variable 1)	Length of forewing (variable 11) Length of face (variable 15) Length from stigma to wing tip (variable 16)	Length of scape (variable 17) Least interocellar distance (variable 18) Ocellocular distance (variable 19)
Length of forewing (variable 11)	Length from stigma tip to wing tip (variable 16)	Length of face (variable 15)
Length of face (variable 15)	Length from stigma tip to wing tip (variable 16) Length of scape (variable 17) Ocellocular distance (variable 19)	Least interocellar distance (variable 18)
Length from stigma tip to wing tip (variable 16)		Length of scape (variable 17) Least interocellar distance (variable 18) Ocellocular distance (variable 19)

[a] Summarized from a computer printout available at the University of Guelph, Department of Environmental Biology.

The discriminant analysis, treating six taxa (of the eight considered in this paper) without regard to sex, showed that certain variables were highly correlated (Table V). Five discriminant functions were derived with four functions being highly significant ($P \leq 0.001$). Based on all five discriminant functions and 18 variables, Table VII was produced which shows the percentage of the predicted groups (i.e., those groups based on quantitative data only) placed correctly into the actual groups (i.e., those groups based on qualitative data). The most important variables for the first four discrimnant functions based on the standardized discriminant function coefficients, appeared to be variables 8 ($\frac{H_t}{H_i}$), 11 (L_F), 12 (L_{RS}), 15 (LF), 16 (ST), 17 (SD), and 19 (OOD). Using four functions based on these eight variables an 81.9% correct, predicted group-membership was obtained. The discriminant analysis, treating the two sexes as groups without regard to taxon, gave a 91.2% correct, group-membership based on one discriminant function.

The results of the two-way ANOVAs can be summarized as follows:

1. interaction between sexes and taxa was significant for variables 17 (SD) ($P \leq 0.001$), 15 (LF) ($P < 0.05$), and 13 (L_S) ($P < 0.05$).

2. differences between sex means were significant for variables 2 ($\frac{WP}{LP}$) ($P < 0.01$) and 9 ($\frac{L_I}{L_{II}}$) ($P < 0.05$).

TABLE VI. Numbers of specimens of the North American species *Elampus marginatus* and *E. viridicyaneus* (Hymenoptera, Chrysididae) collected during each month (from data labels on pinned specimens).

Species	January	February	March	April	May	June	July	August	September	October	No date	Total
Elampus marginatus (black colour form)	0	0	0	0	0	11	20	4	0	0	4	39
E. marginatus (green-black colour form)	0	0	0	0	15	54	254	37	2	5	18	385
E. marginatus (green colour form)	0	0	0	7	14	48	66	16	2	2	15	170
E. marginatus (other colour forms)	0	0	1	11	37	97	256	55	19	12	20	508
E. marginatus (all colour forms combined)	0	0	1	18	66	210	596	112	23	19	57	1,102
E. viridicyaneus	1	0	0	6	60	293	87	8	1	0	28	484

TABLE VII. Discriminant analysis for six North American taxa of *Elampus* (Hymenoptera, Chrysididae): predicted results giving percentage of correct placement of predicted groups into actual groups based on five discriminant functions and 18 variables[a].

Actual group	No. of cases	Predicted group membership Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Group 1 (*E. nitidus californicus*)	19	16. 84.2%	0. 0.0%	0. 0.0%	3. 15.8%	0. 0.0%	0. 0.0%
Group 2 (*E. hyalinus*)	30	0. 0.0%	30. 100.0%	0. 0.0%	0. 0.0%	0. 0.0%	0. 0.0%
Group 3 (*E. marginatus*)	18	0. 0.0%	0. 0.0%	15. 83.3%	3. 16.7%	0. 0.0%	0. 0.0%
Group 4 (*E. nitidus nitidus*)	28	5. 17.9%	0. 0.0%	4. 14.3%	19. 67.9%	0. 0.0%	0. 0.0%
Group 5 (*E. rotundus*)	10	0. 0.0%	1. 10.0%	0. 0.0%	0. 0.0%	9. 90.0%	0. 0.0%
Group 6 (*E. viridicyaneus*)	20	0. 0.0%	0. 0.0%	0. 0.0%	0. 0.0%	0. 0.0%	20. 100.0%

Percentage of "grouped" cases correctly classified: 87.20%.

[a] Taken from computer printout. Available at the University of Guelph, Department of Environmental Biology.

3. the mean of at least one taxon was significantly different ($P \leq 0.001$) from the others for variables 1 (TL), 2 ($\frac{WP}{LP}$), 3 ($\frac{WH}{LH}$), 5 ($\frac{W_{II}}{L_{II}}$), 6 ($\frac{W_{III}}{L_{III}}$), 7 ($\frac{W_t}{H_i}$), 8 ($\frac{H_t}{H_i}$), 11 (L_F), 12 (L_{RS}), 13 (L_S), 14 (WF), 15 (LF), 16 (ST), 17 (SD), 18 (LID), and 19 (OOD). Variables which were highly significant for taxa ($P \leq 0.001$) but showed no significant interaction or sex difference were subjected to Scheffé's multiple range test at the 0.01% level of significance. The results are summarized in Table III.

In general, for North America, the species of *Elampus* were found to be very similar with few, and often disappointingly variable, diagnostic characters. Therefore, in the present study relatively broad species limits were recognized and considerable attention was given to describing intraspecific variation. Rather than giving formal latin names to distinct colour forms or possible new species the philosophy of a relative "lumper" was adopted.

Systematics
Genus *Elampus* Spinola

Elampus Spinola, 1806, Ins. Liguriae 1: 10; Spinola, 1808, Ins. Liguriae 2: 75, Spinola, 1851, Gay Hist. Fisic. Chile 5(6): 412; Dahlbom, 1854, Hym. Europae 2: 38; Norton, 1879, Trans. Am. ent. Soc. 7: 233 (ex parte); Provancher, 1881, Nat. Canad. 12: 302 (ex parte); Frey-Gessner, 1887, Fn. Insect. Helvet.: 30 (ex parte); Morice, 1896, Entomol. mon. Mag. 32: 118; Alayo, 1974, Acad. Cien. Cuba, Ser. Biol. No. 52: 4, 12.

Ellampus Agassiz, 1846, Nomen. Zool. Index Universalis: 136 (emendation); Mocsáry, 1889, Monogr. Chrysididarum: 64, 65 (as subgenus *Notozus);* Friese, 1926, Franch. Verlangshand.: 184, 185 (ex parte); Bodenstein, 1939, Trans. Am. ent. Soc.: 126.

Elampos Dahlbom, 1854, Hymenoptera Europae II:xv (typographical error).

Notozus Förster, 1853, Verh. Naturh. Ver. preuss. Rheinl. 10: 331; Taschenberg, 1866, Die Hymenopteren Deutschlands VIII: 148, 149 (nec *Elampus* Taschenberg, 1866: (148); Tournier, 1879, Annls. Soc. ent. Belg. 22: 89; Aaron, 1885, Trans. Am. ent. Soc. 12: 212, 217 (nec *Elampus* Aaron, 1885: 215); Buysson, 1891, Species des Hyménoptères d'Europe et d'Algérie VI: 95 (nec *Ellampus* Buysson, 1891: 116); Bischoff, 1913, in Wytsman: Genera Insectorum 151: 4, 5 (nec *Ellampus* Bischoff, 1913: 7); Trautmann, 1927, Die Goldwespen Europas: 23; Trautmann, 1930, in Schmiedekneckt: Die Hymenopteren Nord- und Mitteleuropas: 488, 489; Berland and Bernard, 1938, Fn. France 34: 25, 26 (nec *Elampus* Berland and Bernard, 1938: 31); Edney, 1940, Occ. Pap. natn. Mus. sth. Rhod. 9: 33, 35; Atanassov, 1940, Izv. bulg. ent. Druzh. 11: 205; Balthasar, 1946, Acta ent. Mus. Natl. Pragae. XXIV, 324: 225; Benno, 1950, Publties natuur. Genoot. Limburg III: 18; Balthasar, 1951, Acta ent. Mus. Natl. Pragae XXVII, Suppl. 2: 38; Balthasar, 1954, Fn. ČSR 3: 72; Haupt, 1956, Abh. Ber. Mus. Tierk. Volkerk. Dresden 23: 48; Noskiewicz and Pulawski, 1958, Polski Związek Ent. 24: 16; Móczár, 1964, Annls. hist-nat. Mus. natn. hung. 56: 439; Móczár, 1967, Fn. Hungariae 86: 19; Semenov-Tian-Shanskij, 1967, Trudȳ zool. Inst., Leningr. 43: 120 (nec Semenov-Tian-Shanskij, 1967, 119).

Notorus Antiga and Bofill, 1903, Catálech insectes Catalunya: 3 (typographical error).

Omalus Linsenmaier, 1959, Mitt. schweiz. ent. Ges. 41: 22 (as subgenus *Notozus).*

Type-species: *Chrysis panzeri* Fabricius 1804, designated by Latreille (1810).

Adults. Small to medium, relatively robust wasps varying in length from three to eight millimeters. Colour variable, metallic green, blue, violet, black or coppery. Body more or less completely covered with punctures, each usually bearing a fine hair from its centre.

Head. Scapal basin wide, shallow, striate, rugose or smooth (Figs. 56, 57), indistinctly separated from rest of face; separated from inner margins of compound eyes by one or two rows of round punctures which become smaller below. Front distinctly punctuate with round, medium, contiguous to moderately spaced punctures. Clypeus slightly bulging medially; smooth with a few minute, shallow, indistinct punctures; its apical margin incised below each antennal socket. Ocellar triangle with small to minute, irregularly spaced punctures, with a shallow, indistinct, groove sometimes joining hind margins of lateral ocelli. Vertex with slightly larger, more irregularly spaced punctures than in ocellar triangle and a small, smooth area posterolateral to each lateral ocellus (Fig. 60). Genae relatively broad above, narrow below, irregularly punctate to rugose-punctate; smooth along compound eyes. Hairs of genal fringe fine, long, relatively sparse in males; coarse, short, dense in females (Figs. 52, 53). Malar space very narrow, less than one ocellar diameter in width. Scape indistinctly and finely punctate above, smooth below. Pedicel brown, paler apically. Flagellum brown or black, covered with short, dense, white setae, first flagellomere longer than second, and second slightly longer than third; remaining flagellomeres subequal (Fig. 65). Mandibles with two inner teeth (Fig. 54), metallic green or blue basally, light brown medially, dark to reddish brown at apices of inner teeth and apex; fringed with a few long, white setae.

Thorax. Pronotum longer and narrower than head (Fig. 60), tapering anteriorly; small, densely spaced punctures medially along anterior margin, elsewhere medium, densely to moderately spaced punctures, often loosely clumped medially and contiguous laterally; sides concave and rugose-punctate. Mesonotum more or less evenly covered with small to medium, densely spaced punctures anteriorly, between and just outside notaulices (Fig. 55), becoming larger posteriorly, largest between notaulices near hind margin. Notaulices fine, complete, ending in elongate pits at anterior and posterior margins. Scutellum with large, distinct, round to angular, contiguous punctures, slightly smaller laterally, ending in a deep, striate pit next to insertion of hind wings (Fig. 72); a small, impunctate triangle medially on anterior margin, hind margin sometimes impunctate as well. Postscutellum produced into a distinct, backward-projecting blade with parallel or slightly tapering sides, rounded or truncated apically. Postscutellar punctures large, deep, distinct, angular, and contiguous becoming smaller, shallower, and more rounded laterally. Underside of blade with medium, angular, contiguous punctures. Propodeum produced laterally into a more or less sharply pointed spine. Punctation variable; medially a narrow triangle of small to medium, angular, contiguous punctures bordered laterally by two or three very large, angular foveolae; large, angular to round, contiguous punctures lateral to foveolae, becoming smaller anteriorly and towards apex of spine (Fig. 61). Underside of spine deeply excavated, smooth to indistinctly striate (Fig. 72). Mesopleura as in Figure 72.

Wings. Venation as in Figure 11. Basal cell of forewing asetose or nearly so. Remainder of wing covered with short setae. Radial sector relatively short, variable in length. Veins brown, wing membrane clear within basal cells, brownish beyond cells, rarely either completely brown or completely clear.

Legs. Green, blue, or violet, usually metallic. Apex of tibiae and tarsi yellow to brown. Fore femore broadened basally, as wide as deep. Mid and hind femora compressed, usually distinctly punctured above, smooth below. Tibiae, especially apically, more evenly and distinctly punctured than femora. Tarsal claws with one to four inner teeth (Figs. 66-69).

Abdomen. First and second tergites covered in minute, round, distinct, usually moderately spaced punctures medially, becoming small, oval, usually densely spaced laterally and around basal pit of first tergite. Third tergite normally more densely and coarsely punctured than first or second tergites, with small to medium punctures, larger and less distinct laterally and apically. Lateral margins bisinuate, with a shallow groove above apical sinus. Apical, snout-like projection more or less prominent, relatively long, narrow and readily visible to short, broad and not readily visible; truncated apically, the truncation filled with a coloured membrane, varying in colour from yellow to black and incised more or less deeply below. Shape of truncation variable (Figs. 26-35). Sternites green, blue or violet medially, brown laterally, covered with minute, densely spaced punctures (Figs. 15-18, 70).

Pilosity. Head, except scapal basin, with fine, whitish hairs longest on front, shortest along inner, lower margin of compound eyes. Thorax evenly covered with erect, whitish pubescence, appressed on anterior, ventral face of mesopleura, almost absent on posterior face. Legs with long, fine, white, dense hairs on coxae, shorter and sparser on femora, rather setose on tibiae and tarsi. Abdomen with appressed to subdecumbent hair along, and just above, anterior margin of first tergite, lateral margins of first and second tergites, and hind margin of second tergite. Third tergite evenly covered with longer hair except medially along anterior margin (Fig. 71).

Male Genitalia. Similar to those of *Omalus* (Fig. 51) (Bohart and Campos, 1960), but cuspides are long and narrow, not partly enclosing aedeagus, and digiti are relatively narrower (Figs. 14, 43-50).

Immature stages are unknown.

Sexual Dimorphism. In the subfamily Hedychrinae, only *Elampus* has distinct, secondary sexual characters sexual characters which are found in all species except for some in South America.

The differences between males and females are:

1. Genal fringe short, dense, setose in females (Fig. 52); long, sparse, fine in males (Fig. 53).
2. Inner margins of compound eyes slightly convergent below in females (Figs. 8, 56); straight or slightly divergent in males (Figs. 9, 57).
3. Genae relatively broad above in females; relatively narrow in males. This character is somewhat variable and difficult to use.
4. Hind margin of third sternite concave in females; convex in males (Figs. 17, 18).
5. Underside of base of fore femora usually angular and projecting in females, and fringed with short, dense setae; usually rounded in males with relatively long, fine hairs (Figs. 40-41).

Other characters for separating the sexes were given by Buysson (1891) but most of the differences proposed were found to be variable and not applicable to *Elampus* although they could be important for distinguishing males and females of *Omalus*. The computer analysis of quantitative characters gave an almost perfect separation of the sexes but no attempt was made to determine which of the 16 variables were the most important in the separation of the sexes.

Diagnostic Characters for the Genus

The combination of the backwards projecting, blade-like postscutellum, the truncated, membrane-filled, snout-like projection of the third abdominal tergite and the more or less evenly punctured mesonotum is diagnostic for North American species. The male genitalia can also be used to separate *Elampus* from *Omalus*. In *Elampus* the cuspides are long and slender whereas in *Omalus* they are short and broad.

Key to North American Species of *Elampus*

1. Apical truncation of tergite III round or oval, almost completely filled with membrane (Fig. 27); one vertical, inner tooth in each tarsal claw (Fig. 36); radial sector of forewing about one-half length of stigma *rotundus* sp. nov.
   Apical truncation not as above, usually crescent shaped, only partially filled with membrane which is distinctly incised below (Figs. 26, 28-35); two to four inner teeth in each tarsal claw (Figs. 37-39) (if only one tooth it is set at an angle); radial sector of forewing as long as, or only slightly shorter than, stigma 2
2. Wings hyaline, not at all infuscated beyond venation; each tarsal claw with one or two angled inner teeth .... *hyalinus* (Aaron)
   Wings more or less infuscated beyond venation; each tarsal claw with three or four inner teeth (rarely only two in some very small specimens) 3
3. Usually large, relatively robust, wasps (5.3-8.2 mm, $\bar{X} = 7.0$ mm); apical, snout-like projection of tergite III, seen from above, short, not projecting very distinctly beyond the continuous line of the margin of tergite III; membrane in apical truncation usually black, concave, with an incision greater than one half the height of the truncation (Fig. 28); three or four inner teeth in each tarsal claw .... *viridicyaneus* Norton
   Usually smaller, relatively more slender, wasps (4.1-7.1 mm, $\bar{X} = 5.7$ mm); apical snout-like projection of tergite III, seen from above, usually long, projecting distinctly beyond the continuous line of the margin of tergite III; membrane in apical truncation usually brown, flat, with an incision less than one half the height of the truncation; usually three inner teeth in each tarsal claw (rarely only two inner teeth in some very small specimens) 4
4. Colour of thorax, especially propodeum, contrasting sharply with colour of abdomen, colour of tergites bright green with a more or less extensive colour varying to coppery-red, rarely only bright green without copper or coppery-red without green 5
   Colour of thorax, especially propodeum, not contrasting sharply with colour of abdomen; colour of tergites variable — green, blue-green, violet or black, occasionally brown or brass coloured 6
5. Average size 4.0-6.0 mm ($\bar{X} = 5.1$ mm, $n = 35$); punctures on front distinct, medium in size, mostly contiguous; scapal basin distinctly striate, very little smooth space between punctures of front and striations of scapal basin. Mexico to Canada (Fig. 3) .... *nitidus nitidus* (Aaron)
   Average size 3.8-5.4 mm ($\bar{X} = 4.7$ mm, $n = 20$); punctures on front indistinct, small, densely to moderately spaced; scapal basin almost smooth to finely and indistinctly striate; considerable smooth space between punctures of front and striations of scapal basin. Coastal California (Fig. 3).... *nitidus californicus* subsp. nov.

6. Ratio of width of apical truncation to maximum width of tergite III less than 0.31 (usually about 0.25); punctures on tergite II separate and distinct *marginatus* (Patton)
   Ratio of width of apical truncation to maximum width of tergite III greater than 0.31 (usually about 0.33); punctures on tergite II apparently coalescing and indistinct, giving the tergite a roughened appearance under low magnification 7
7. Colour mainly green .... *aaroni* Bodenstein
   Colour mainly violet .... *versicolor* Norton

Elampus hyalinus (Aaron)
Figs. 26, 39, 42, 48, 68
Distribution map Fig. 1

Notozus hyalinus Aaron 1885: 217, 218; original description.
Notozus hyalinus; Cresson 1887: 253; North American list.
Ellampus hyalinus; Mocsáry 1889: 76, 77; key and original description quoted.
Elampus hyalinus; Dalla Torre 1892: 13; world catalogue.
Notozus hyalinus; Bischoff 1913: 6; world list.
Notozus hyalinus; Cresson 1928: 29; type material.
Notozus hyalinus; Brimley 1938: 435; North Carolina list.
Notozus hyalinus; Bodenstein 1951: 719; North American catalogue.

Description. Males. Length 3.9-5.8 mm ($\overline{X} = 4.5$ mm, n = 10). Other measurements in Table II. Colour green to blue-green often with a violet tinge or reflections on the following: scape, scapal basin, hind margin of vertex and genae, pronotum, mesonotum, laterally on postscutellum, propodeum, and abdomen. Rims of punctures of scutellum and apex of blade of postscutellum dark brown or black. Flagellum brown usually with a reddish tinge. Membrane of wings clear, without brown colouring, with purple or green iridescence in certain lights. Posterior margin of second tergite and membrane in apical truncation usually brown to reddish-brown. On those parts of the specimen having a metallic colour the underlying brown cuticle is often apparent, especially on the scape and legs.

Scapal basin usually rugose, especially laterally, occasionally smooth or indistinctly striate. Punctures on abdomen sparsest on first tergite, densest on third, often with a smooth area with scattered punctures on anterior face of first tergite above basal pit. Lateral margins of third tergite bisinuate, the basal sinuation usually shallower. Apical snout-like projection distinct, narrow, readily visible from above or from the side, sharply truncated apically. Incision in apical membrane relatively shallow (Fig. 26). Tarsal claws with one or two inner teeth set at an angle (Figs. 39, 68). Underside of base of fore femora rounded. Male genitalia as in Figure 48. Measurements in Table IV.

Females. Length 3.3-5.8 mm ($\overline{X} = 4.7$ mm, n = 25). Other measurements in Table II. Colour of face darker than in males, usually with more extensive violet tinge. Underside of fore femora prominent, angular (Fig. 42).

Variation. The amount and distribution of violet colour on the body varies considerably. The colour of the apical membrane varies from yellow (one specimen seen) to black. The density of punctation on the abdomen also varies slightly. One Mexican specimen had a faint brown tinge in the wing membrane. The depth of the apical incision varies from very shallow to almost half the height of the truncation (Fig. 26).

Diagnosis. The combination of clear wings and one or two angled, inner teeth in each tarsal claw is diagnostic. The more or less rugose scapal basin and relatively shallow incision in the apical membrane are additional features not usually found in other North American species.

Elampus albipennis Mocsáry, from Eastern Europe and the USSR, also has clear wings and two inner teeth in the tarsal claws.

Type Material. Aaron (1885) described *E. hyalinus* on the basis of three specimens from Montana and Nevada. The female paratype seen was labelled as follows: "Paratype 4912, Nev.". The specimen is quite dirty and the wings partly torn and stuck together making it difficult to see their colour. However, it is a typical *hyalinus*. Its measurements are given in Table I. The lectotype and other paratype were not seen. All three specimens bear the number 4912 and are deposited in the Academy of Natural Sciences, Philadelphia.

Material Examined. 22 males, 53 females. Collection dates extend from 2 April (Blythe — 18 mi. W., Riverside Co., California) to 24 September (Raleigh, North Carolina).

CANADA: ONTARIO: Chatterton.

UNITED STATES: ARIZONA: Apache (3-5 mi. S.W.); Benson (5 mi. S.); Cameron (22 mi. N.); Douglas; Oak Creek Canyon; Portal (5 mi. W., S.W. Research Station, Chiricahua Mountains, 5400'); Toltec (9 mi. S.); Wilcox (and 2.5 mi. S). CALIFORNIA: Blythe (18 mi. W.). COLORADO: State record only; Crook; Lyons; Mont Alto, West Chicago Creek (Clear Creek Co.); Wray. CONNECTICUT: E. Hartford. FLORIDA: Bratt. ILLINOIS: Kankakee. KANSAS: Burdett; Downs; Lawrence; Liberal; Manhattan; Menlo; Clark Co. (County record only); Clay Co. (County record only). MICHIGAN: Grand Junction. MONTANA: State record only. NEVADA: State record only (paratype). NEW MEXICO: Alamogordo; Cloudcroft; Elk (8 mi. N.); Mesilla Park (3 mi. E.); Moriarty; Rodeo (13 mi. N.); Ruidoso; Socorro (6.7 mi. W.); White Sands National Monument (Chaves Co.); Torrance Co. (County record only). NORTH CAROLINA: Raleigh. OKLAHOMA: Grandfield. SOUTH DAKOTA: Maurine. TEXAS: David Mountains (Jeff Davis Co.); Dell City (7 mi. N.E.); Imperial; Romero. UTAH: Greenriver; Lehi.

MEXICO: Concho (Chihuahua); Lake Zocoalco (Jalisco).

Floral Records. *Baccharis glutinosa, Chenopodium watsoni, Melilotus alba.*

Biology. Nothing is known about the life history and immature stages of *E. hyalinus*. No hosts have been recorded.

Elampus rotundus, sp. nov.
Figs. 27, 36, 49, 57, 69, 75
Distribution map Fig. 1

Description. Holotype male. Length 4.4 mm. Head green with violet tinge on clypeus, laterally on face, in ocellar triangle, along posterior margin and in punctures of vertex. Scape brown with a violet tinge. Flagellum dark brown, apical flagellomeres lightest. Pronotum green with bluish tinge and traces of violet laterally. Mesothorax and mesopleura green. Scutellum blackish with green-blue in punctures. Postscutellum dark brown on blade, metallic green basally and laterally. Propodeum green. Legs brown with blue and green. Apex of tibiae and tarsi yellow. Forewings slightly tinged with brown beyond venation, clear basally. Abdomen blue-green with violet tinge medially, green laterally. Lateral margins of third tergite dark brown. Membrane of apical truncation with dark brown rim, yellowish-brown medially and lighter above.

Scapal basin finely rugose, smooth above. Front with distinct, round, small to medium, moderately spaced punctures (Fig. 57). Hairs of genal fringe sparse, fine, whitish. Pronotum with medium to small, irregularly spaced punctures on dorsum. Edges of mesopleura rounded, not sharp and distinct. First and second tergites with minute, round, distinct punctures medially, larger and more densely spaced laterally; moderately to sparsely spaced on first tergite, densely to moderately spaced on second tergite with a round, impunctate area above basal pit. Third tergite with minute, contiguous punctures medially becoming small to medium laterally and apically. Apical snout-like projection readily visible from above or the side. Apical truncation circular, completely filled with membrane which is only slightly incised below (Fig. 27). Lateral margin of third tergite bisinuate, basal sinuation very shallow, almost straight. Base of fore femora evenly rounded below. Tarsal claws with a single, small, vertical, inner tooth (Figs. 36, 69). Radial sector very short, about half as long as stigma. Male genitalia as in Figure 49. Measurements and ratios as follows: width/length of head, 2.5; width/length of pronotum, 1.8; width/length of tergites I, II, 111, 3.3, 1.5, 1.6, respectively; width/height of truncation, 0.92; ratio of flagellomere I/flagellomere II, 1.43; forewing length, 3.2 mm; stigma length, 0.33 mm; radial sector length, 0.18 mm; distance between compound eyes, 0.77 mm; distance from median ocellus to clypeal margin, 0.81 mm; length of scape, 0.39 mm; distance between lateral ocelli, 0.26 mm; distance from compound eye to lateral ocellus, 0.23 mm; diameter of median ocellus, 0.09 mm.

Allotype (female). Length 5.6 mm. Similar to male except for secondary sexual differences and larger size.

Variation. Males: 4.3-5.1 mm ($\overline{X}$ = 4.6 mm, n = 6). Females: 3.8-5.9 mm ($\overline{X}$ = 5.0 mm, n = 9). Other measurements in Table II. There is some variation in colour and punctation. The shades of green and the extent of violet tinge on the different sclerites varies among specimens. The colour of the postscutellum, contrasting strongly with the colour of the mesothorax varies from brown to black with more or less green, blue or violet tinge in some of the punctures. The apical membrane varies from yellow to brown with a darker brown, or occasionally black rim.

The scapal basin is usually finely rugose, especially laterally and around the antennal sockets, but may be smooth. Body punctation varies slightly in density. The apical truncation is usually circular but may be oval (Figs. 27, 75). Male genitalia have relatively short digiti and cuspides (Fig. 49), similar to certain South American species such as *E. gayi* Spinola (Fig. 50). Ratios are: digitus/cuspis length, 0.58; cuspis/paramere length, 0.52 (n = 2).

Diagnosis. The combination of the circular apical truncation almost completely filled with membrane, the single, vertical inner tooth in each tarsal claw, and the very short radial sector is diagnostic. The name *rotundus* refers to the circular apical truncation.

E. rotundus is more closely related to South American species of *Elampus* than to other North American species.

Type Material. Holotype (male). Labelled as follows: "Bard, Imperial Co. Cal., 14-VI-1965/Ex cotton/Akins & Roy Coll./CSDA" (blue label). The holotype is deposited in the University of California, Davis.

Allotype (female). Labelled as follows: "Brownsville, Texas, June 25, 1908/ sweeping, S. Tex. Garden/ex. coll. M. A. Cazier". The allotype is deposited in the American Museum of Natural History, New York. Labels indicating the sex and type designation were added to each specimen.

Of the remaining 17 specimens, four are in poor condition or poorly labelled (each labelled: Tex. 1576/from coll. USNM) and are not considered as paratypes.

Paratypes. UNITED STATES: CALIFORNIA: Bard, Imperial Co., VIII-18-1965, H. Ray (UCD) 1 ♀. MISSOURI: Columbia (ex malaise trap), VII-17-1967, F. D. Parker (UCD) 1 ♀. OKLAHOMA: Grandfield, VII-5-1937, Standish-Kaiser (MSU) 1 ♀; Waurika, VII-4-1937, Standish-Kaiser (UCD) 1 ♀. TEXAS: Bay City, V-4-1953, R. H. Beamer (SNOW) 1 ♀; Brownsville, 1929, no name (USNM) 1 ♀; Brazos Co. (County record only), VII-24-1957, A. H. Alex (UCD) 1 ♂; Plano, VII-?-1907, E. S. Tucker (USNM) 1 ♂; Plano, VIII-14-1905, C. R. Jones (USNM) 1 ♂.

MEXICO: El Limon (Tamaulipas), VI-17-1953, no name (CIS) 1 ♀; San Pedro (2 mi. N.E.) (Baja California), IX-19-1967, J. Chemsak, A. & M. Michelbacher (CIS) 1 ♀; Navajo (Sonora), IX-27-1966, G. E. & A. S. Bohart (UCD) 1 ♀; Villa Union (Sinaloa), XI-1-1950, A. Alcorn (SNOW) 1 ♀.

Floral Records. *Gossypium hirsutum, Cucumis sativus.*

Biology. Unknown. No hosts have been recorded.

Elampus nitidus nitidus (Aaron) stat. nov.
Figs. 30-32, 46, 54
Distribution map Fig. 3

Notozus nitidus Aaron 1885: 218, original description.
Notozus nitidus; Cresson 1887: 253, North American list.
Notozus nitidus; Cameron 1888: 458, Central American list.
Notozus nitidus; Provancher 1889: 222, Canadian list.
Ellampus nitidus; Mocsáry 1889: 72, 76: key, original description quoted.
Ellampus nitidus; Dalla Torre 1892: 14, world catalogue.
Notozus nitidus; Bischoff 1913: 6, world list.
Notozus nitidus; Cresson 1928: 30, type material.
Elampus nitidus; Bodenstein 1951: 719, North American catalogue.
Elampus nitidus; Gibson and Carillo 1959: 200, Mexican list.
Ellampus mexicanus Mocsáry 1889: 72, syn. nov.
Ellampus mexicanus; Dalla Torre 1892: 13, world catalogue.
Notozus mexicanus; Bischoff 1913: 6, world list.

Description. Males. Length 4.0-6.0 mm ($\overline{X}$ = 5.0 mm, n = 15). Other measurements in Table II. Colour of head and thorax green, blue-green or violet. Abdomen copper coloured, rarely light green without copper colour. Head light or dark green often with more or less violet in ocellar triangle, along hind margin of vertex and on clypeus. Scapal basin usually lighter green than vertex, often with gold reflections. Pronotum, mesonotum and mesopleura green to blue-green, often with more or less violet tinge or reflections along margins of each sclerite, rarely completely violet on mesopleura. Scutellum green in punctures. Postscutellar blade black apically, rarely brown; green or violet basally, laterally and under blade. Propodeum green, blue-green or violet. Wings hyaline basally, brown stained beyond venation. Abdomen light green, gold and copper, the copper colour usually extending over the central area of each tergite with gold-green or green laterally; rarely either all green or deep coppery-red. Often a dark purple-copper longitudinal median streak on second tergite and a purple tinge near apex of third tergite. Snout-like projection dark brown or black above apex. Apical membrane black, brown or, rarely, yellow. Sternites green or blue-green, sometimes violet.

Scapal basin striate, the striations usually distinct, fine, close together and curved but varying to rather indistinct, wavy, further apart and straight. Punctures of front distinct, medium-sized and contiguous, rarely densely spaced. Punctures on first tergite minute to small, moderately spaced medially on posterior half of tergite, dense to contiguous around basal pit, often with an impunctate spot or longitudinal line medially. Punctures on second tergite minute, distinct, moderately spaced medially to small, rather indistinct and densely spaced in some Mexican specimens, and oval, small to medium, densely spaced to contiguous laterally. Often a narrow impunctate border along anterior margin. Punctures of third tergite small, densely spaced to contiguous and distinct basally to medium sized and less distinct apically and laterally. Apical truncation with incision less than half the height of the truncation (Figs. 30-32). Tarsal claws with three inner teeth (as in Fig. 37). Male genitalia as in Figure 46. Measurements in Table II.

Females. Length 4.2-5.6 mm ($\overline{X}$ = 5.1, n = 20). Other measurements in Table II. Scapal basin usually with more or less violet, otherwise similar to males.

Variation. The most noticeable variation is in colour. The thorax varies from green with very little violet to almost completely blue or violet. The amount and intensity of copper on the abdomen varies from almost completely copper to coppery-red with very little green laterally to completely green with no copper. The latter forms are rare and tend to be smaller than average. Mexican specimens tend to have a deeper, more extensive, copper colour than do the more northern ones. In addition, some have the punctures of the abdomen closer together and slightly larger, especially on the third tergite, than those in northern specimens. The depth of the apical incision varies and is often relatively shallower in Mexican specimens (Figs. 31, 32). Despite this variation the Mexican specimens cannot be separated objectively from specimens from Canada or the United States into two groups worthy of specific or subspecific status as the differences are not very constant and their limits, both morphological and geographical, are difficult to define.

Diagnosis. The copper or bright green abdomen contrasting strongly with the dark green, blue or violet thorax (especially the propodeum) is diagnostic. Specimens lacking copper may be confused with the green form of *E. marginatus* but in the latter the green colour of the thorax and abdomen is the same shade and does not contrast sharply.

The European species, *E. panzeri* (Fabricius), *E. spina* (Lepeletier), *E. constrictus* (Förster), and *E. sanzii* (Gorgoza) apparently are similar in colour to *E. nitidus*.

Type Material. Aaron (1885) described *E. nitidus* from two males, one from California and one from Montana. He did not designate a holotype. However, the Montana specimen bears a red holotype label and the California specimen bears a blue paratype label. Presumably, these labels were added later, possibly by Cresson (see Cresson 1928: 1-3). Both specimens were examined and the specimen from California was selected as holotype of *E. nitidus californicus* subsp. nov. (see below). The Montana specimen is considered as the holotype of *E. nitidus nitidus*. Measurements of both specimens are given in Table I. The holotype of *E. nitidus nitidus* is missing three tarsal segments of the left mesothoracic leg and two flagellomeres of the right antenna. It is deposited in the Academy of Natural Sciences, Philadelphia.

Elampus mexicanus was described from seven specimens, including both sexes (Mocsáry, 1889). He did not designate a holotype. Five males were seen, one of which is labelled "typus" on a red label. This specimen is considered as a lectotype. The specimens are very dirty and one specimen lacks a head. They are deposited in the Muséum D'Histoire Naturelle, Geneva. The whereabouts of the other two specimens is unknown.

The specimens of *mexicanus* seen have violet-coloured sternites, a relatively dark (blue-green with considerable violet) coloured thorax, dense or contiguous punctation on the third abdominal tergite, and a relatively shallow incision in the apical membrane (Fig. 32). The colour of the abdomen varies from green with no copper to a deep coppery-red all over. A male labelled *"Notozus mexicanus,* Mocsáry collection" was seen in the British Museum (Natural History) and is virtually identical to the lectotype in the type series. These characteristics agree with those of several other Mexican specimens examined. Possibly these specimens all should be considered as *E. mexicanus.* However, the differences between the Mexican specimens and specimens from further north are relatively small, inconsistent and not easily delimited. Possibly, colour differences could be related to climatic differences (Telford, 1964, Horning, 1969). As there is no clearcut geographical separation of the two groups, *E. mexicanus* is considered to be a synonym of *E. nitidus.*

The male genitalia of one specimen of the type series of *mexicanus* was removed and measured (Table IV). Other measurements for the lectotype are given in Table I. The holotype of *nitidus nitidus* is labelled as follows: "Montana" (white label)/"Type no. 4910" (red label)/*"nitidus* Aaron" (white label with red line near top margin).

Material Examined. 42 males, 62 females. Collection dates extend from 29 May (Furnace Creek, Death Valley, California) to October (Venta de Zopilote, Mexico).

CANADA: ALBERTA: Lethbridge; Pincher. MANITOBA: Aweme; Carberry; Teulon; Virden. SASKATCHEWAN: Big River; Elbow; Little Quill; Moose Jaw; Saskatoon.

UNITED STATES: ARIZONA: Apache (9 mi. N.); Cameron; Eloy (11 mi. W.); San Pedro River, Benson; Toltec (8 mi. S.); Yuma (15 mi. N.). CALIFORNIA: Experimental Farm, (no town) (Imperial Co.); Furnace Creek, Death Valley; Glamis (5 mi. W.); Stove Pipe Wells, Death Valley; Imperial Co. (County record only). COLORADO: Colorado Springs; Denver. IOWA: Sioux City. KANSAS: Aulne; Manhattan; Michigan Co. (County record only); Kalkaska Co. (County record only). MONTANA (State record only) (Holotype). NEBRASKA: Forest Reserve, Halsey; Gothenburg; Niobrara Refuge, Valentine; Rushville. NEVADA: Stillwater (12 mi. E.). NEW MEXICO: Alamogordo (1 mi. S.); Albuquerque; Pinedale; Rosewell; San Mateo. NORTH CAROLINA: Valley of Black Mountains. NORTH DAKOTA: Bismarck; Bottineau; Walcott (11 mi. W.). SOUTH DAKOTA: Brookings; Chamberlain; Elk Point. TEXAS: El Paso; Imperial. WYOMING: Lingle; Tie Hack Campground, Bighorn National Forest (Johnson Co.).

EL SALVADOR: Usulutan.

MEXICO: Anganguco (Type series of *mexicanus);* Concho (Chihuahua); Cuiteco (Chihuahua); Durango (and 6 mi. S.); El Yukon (22 km. W. Toluca) (Mexico); Guadalahara; Hidalgo (6 mi. E. Tulacingo) (Hidalgo); Nombre de Dios (16 mi. S.) (Durango); Petacingo (3 mi. N.) (Puebla); Presidio (Chihuahua); San Jose Viejo (22 mi. S.E. Totalapan) (Oaxaca); Sonoyta (Sonora); Vena de Zopilote (Guerrero).

Floral Records. Alfalfa leaves, *L.* (?) *alyssoides.*

Biology. Unknown. Specimens have been collected up to 8,000 feet (El Yukon, Mexico).

Elampus nitidus californicus subsp. nov.
Figs. 33, 47
Distribution map Fig. 3

Description. Holotype male. Length 4.5 mm. Head green with a black tinge and violet reflections in the ocellar triangle. Lower part of scapal basin brighter green than upper part. Scape brown with a green and violet tinge. Flagellum brown. Pronotum and propodeum green with a black tinge and scattered violet reflections. Mesonotum green. Scutellum and postscutellum largely black with a green tinge and a few violet reflections in punctures of scutellum and basally and laterally on postscutellum. Forewings clear basally, faintly brown beyond venation. Abdomen bright green with extensive copper tinge medially on all tergites. Apical membrane dark brown.

Scapal basin mainly smooth, slightly and indistinctly roughened medially and above antennal sockets. Front with rather indistinct, small to medium, mostly moderately spaced punctures, extending down sides of compound eyes as a few minute, indistinct punctures. Vertex with minute to small, indistinct, sparsely spaced punctures, densely spaced in ocellar triangle. Dorsum of pronotum with small to medium punctures, densely but irregularly spaced. First and second tergites with minute, moderately spaced punctures interspersed laterally with some small to medium ones which are more densely spaced. Punctures around basal pit contiguous. Third tergite with distinct, minute, densely spaced punctures basally; rather indistinct, small to medium and densely spaced laterally and apically. Lateral margins bisinuate, the sinuations subequal. Tarsal claws with three inner teeth. Apical truncation with a relatively shallow incision (Fig. 33). Base of fore femora evenly rounded ventrally. Male genitalia as in Figure 47. Measurements and ratios as follows: width/length of head, 2.2; width/length of pronotum, 1.9; width/length of tergites I, II, III, 2.9, 1.4, 1.6 respectively; width/height of truncation, 1.4; height of truncation/height of incision, 4.0; ratio of flagellomere I/flagellomere II, 1.43; forewing length, 3.3 mm; stigma length, 0.24 mm; radial sector length, 0.22 mm; distance between compound eyes, 0.83 mm; distance from median ocellus to clypeal margin, 0.90 mm; length of scape, 0.45 mm; distance between lateral ocelli, 0.26 mm; distance from compound eye to lateral ocellus, 0.29 mm; diameter of median ocellus, 0.09 mm.

Allotype (female). Length 5.0 mm. Similar to male except for larger size and more intense colour. Head and thorax with more intense and extensive green (with some blue tinge) than holotype. Abdomen deep coppery-red all over with very little green. Scapal basin very evenly and finely striate, smooth above.

Variation. Males: 4.2-5.1 mm ($\bar{X}$ = 4.6 mm, n = 10). Females: 3.8-5.4 mm ($\bar{X}$ = 4.7 mm, n = 10). Other measurements in Table II. Measurements of male genitalia in Table IV. The same variation in colour occurs as in the nominate subspecies. Scapal basin and thorax usually green, sometimes blue-green, rarely violet. Abdomen with more or less copper or reddish-copper, rarely completely green with only a trace of copper. Apical truncation reddish-brown to black. Sternites green, occasionally with blue tinge. Head and thorax in females more frequently blue-green or violet than in males.

Punctation varies slightly in density on the abdomen. The shape of the apical truncation and the depth of the incision vary slightly (Fig. 33).

Diagnosis. The reduced punctation on the front and the almost smooth scapal basin separate most specimens of this subspecies from the nominate subspecies. *E. nitidus californicus* is restricted to coastal California.

Type Material. The California specimen of Aaron's original series of two specimens was selected as holotype of *E. nitidus californicus.* It is labelled as follows: "Cala." (white label)/"Paratype 4910" (blue label). A label indicating the sex and a holotype label were added. The specimen has the left front leg and five flagellomeres of the left antenna missing, otherwise it is in good condition. It is deposited in the Academy of Natural Sciences, Philadelphia. Allotype in University of California, Davis.

Of the remaining 46 specimens, three (from Newhall, Claremont, and Paso Robles) are in poor condition and are not considered as paratypes.

Paratypes. UNITED STATES: CALIFORNIA: Altadena, 15-IV-1944, A. L. Melander (USNM) 1 ♂ : Arroyo Mocho (16 mi. S. Livermore), 9-IV-1957, D. Burdick (CAS) 1 ♂; Arroyo Seco Camp (Monterey Co.), 1-V-1960, F. D. Parker, (UCD) 1 ♂; Borrego Valley (San Diego Co.), 18-IV-1957, R. M. Bohart (U. Guelph) 1 ♀; Bradley, 4-IV-1957, R. H. Allen (LINS) 1 ♂; Claremont, no date, Baker, C. H. Muzzall, 3 ♀, 7 ♂, UCR (4), UCD (2), CORN (2), CAS (2); Cronise (San Bernardino Co.), 9-IV-1940, K. S. Hagan (UCD) 1 ♀; Cuyama Valley (Kern Co.), 10-IV-1932, E. P. Van Duzee (CAS) 1 ♂; Grapevine, 12-IV-1932, E. P. Van Duzee (CAS) 1 ♀; Herkey Creek, San Jacinto Mountains, 20-V-1939, E. G. Linsley (UCD) 1 ♀; Lake Mathews, 16-IV-1963, A. L. Melander (USNM) 1 ♂; Newhall (Los Angeles Co.), 20-IV-1940, R. M. Bohart (UCD) 1 ♀; Paso Robles, ?-IV-1928, no name, (CIS) 1 ♀; near Red Rock Canyon (25 mi. N.E. Mojave) (Kern Co.), 14-IV-1962, C. MacNeil, D. Renz, R. Brown (CAS) 1 ♀; Riverside, 21-V-1925, Timberlake (UCR) 1 ♂; San Diego, 5-IV-1891, F. H. Blaisdell (CORN) 1 ♂; Santa Cruz Mountains (Santa Clara Co.), 25-IV-1913, J. C. Bridwell (USNM) 1 ♂; Split Mountain, Anza Desert State Park (San Diego Co.), 1-IV-1955, W. R. M. Mason (CNC) 1 ♀; Yorkville (Mendocino Co.), 24-IV-1928, 7 ♀, 5 ♂ and 17-V-1929, 1 ♀, 2 ♂, E. P. Van Duzee (CAS); San Diego Co. (County record only), no date, R. M. Bohart (CAS) 1 ♂.

Floral Records. *Pacelia* sp.

Biology. One specimen was collected on sand dunes (Borrego Valley, R. M. Bohart). The very early flight period (all specimens collected in April and May) is unusual and shows allochronic separation with *E. nitidus nitidus.*

Elampus viridicyaneus Norton
Figs. 6-10, 15-25, 28, 38, 43, 55, 56, 58, 59, 60, 61, 65, 66, 73
Distribution map Fig. 2

Elampus viridicyaneus Norton 1879: 235; original description.
Notozus viridicyaneus; Aaron 1885: 217, 219; key, redescription.
Notozus viridicyaneus; Cresson 1887: 253; North American list.
Notozus viridicyaneus; Provancher 1889: 220 ,222; Canadian list (?).
Ellampus viridicyaneus; Mocsáry 1889: 77; key, redescription quoted.
Ellampus viridicyaneus; Dalla Torre 1892: 19; world catalogue.
Notozus viridicyaneus; Bischoff 1913: 7; world list.
Notozus viridicyaneus; Viereck 1916: 603; key, Connecticut list.
Notozus viridicyaneus; Taylor 1928: 990; North Carolina list.
Elampus viridicyaneus; Cresson 1928: 30 ; type material.
Elampus viridicyaneus; Bodenstein 1951: 719; North American catalogue.
Elampus viridicyaneus; Krombein 1958: 94; host record.
Elampus viridicyaneus; Krombein 1963: 261; biology.
Notozus viridicyaneus; Evans 1966: 53: host biology.
Elampus viridicyaneus; Kurczewski 1970: 192, 196, 199; ecology.
Elampus spinosus Provancher 1881: 302; key, original description.

Elampus spinosus; Provancher 1883: 581; key, original description quoted.
Notozus spinosus; Aaron 1885: 219; synonomy.
Elampus spinosus; Dalla Torre 1892: 19; synonomy.
Elampus spinosus; Bodenstein 1951: 719; synonomy.
Elampus connexus Viereck 1906: 192; new synonomy.
Notozus connexus; Bischoff 1913: 6; world list.
Elampus connexus; Bodenstein 1951: 519; North American catalogue.

Description. Males. Length 5.3-7.7 mm ($\overline{X}$ = 7.2 mm, n = 10). Other measurements in Table II. Colour dark green, blue-green or blue, often with more or less violet tinge; rarely completely green or violet. Head green often with considerable violet tinge in ocellar triangle, on front, hind margin of vertex and genae, and on scape; often with gold tinge or reflections in scapal basin. Pedicel shiny black usually with green or violet tinge. Flagellum dull black, apical flagellomere sometimes dark brown. Thorax, except for postscutellar blade, green or blue-green with more or less violet tinge. Blade black apically. Wings clear basally, dark brown beyond venation, sometimes brown basally as well. Abdomen, except for black basal pit, green, blue-green or blue with more or less violet tinge especially on dorsum of second tergite, sometimes completely green with no violet or completely violet with no green. Membrane of apical truncation shiny black or very dark brown.

Punctation usually more densely spaced than in other species. Scapal basin striate, striations usually fine, distinct, close together and curved (Fig. 56), less often coarser, further apart and straight (Figs. 8, 9). Front with small to medium, round, distinct, contiguous or, rarely, dense punctures which are slightly smaller posteriorly. Punctures of pronotum medially, small to medium, distinct, mostly densely spaced, sometimes moderately spaced and more or less clumped (Fig. 60). Mesonotum as in Figure 55. Postscutellum and propodeum as in Figure 61. Tarsal claws with three or four inner teeth (Figs. 38, 66). Punctures of abdomen distinct, round, minute on first and second tergites medially, slightly larger and oval laterally, often with two distinct sizes interspersed; puncture density variable — usually dense to moderate medially, dense to contiguous laterally, rarely sparse all over. Punctures on third tergite distinct, angular, contiguous, rarely dense, slightly larger apically and laterally (Fig. 73). Apical snout-like projection broad, short, usually not visible from the side or above, often giving the tergite an evenly rounded appearance. Shape of truncation as in Figure 28. Incision deep, usually greater than half the height of the truncation. Membrane usually concave, and sunk into the apical, snout-like projection, sometimes flat. Third sternite as in Figure 18. Male genitalia as in Figures 43, 58, 59. Measurements in Table IV.

Females. Length 6.8-8.2 mm ($\overline{X}$ = 7.7 mm, n = 10). Other measurements in Table II. Scapal basin dark green to blue-green with more or less violet. Visible sternites and hidden tergites and sternites as in Figures 15-17, 19-25.

Variation. The colour is basically the same in most specimens. However, the amount of violet varies, especially on the abdomen. A few specimens were either completely violet or completely green. The amount of brown on the wings is variable. Most specimens had the basal area hyaline but some had more or less brown. Specimens which were considerably or completely violet often had completely brown wings. Although size is relatively constant and most specimens are large and robust, compared to other species, some specimens are very small, about the same size as *E. marginatus*. The shape of the third tergite and the distinctness of the apical snout-like projection varies from very short and broad to somewhat longer and more prominent. The depth of the incision in the apical truncation is usually greater than half the height of the truncation but can be less. In general, *E. viridicyaneus* is extremely constant in size, colour, and structure throughout its large range — specimens from Alaska, California, Florida, and Newfoundland being very similar to each other.

Diagnosis. The large, robust appearance; characteristic blue or blue-green colour of the abdomen; relatively short, broad, finely and contiguously punctured third abdominal tergite; very short, broad, apical snout-like projection, hardly visible from above or the side; and the apical truncation filled with dark brown or black, shiny, often sunken (concave) membrane, which has an incision usually greater than half the height of the truncation, are diagnostic. The presence of four inner teeth in the tarsal claw also distinguishes this species but many specimens only have three teeth.

Despite the relatively numerous characteristics which can be used to identify this species, and its relatively constant appearance throughout its range, a number of specimens were very similar to certain specimens of *E. marginatus* and could not be separated from them with certainty.

Type Material. Norton (1879) described *E. viridicyaneus* from a single male specimen (not a female as indicated in his original description). The holotype was examined and is a typical specimen in all respects. Its measurements are given in Table I. The specimen was in excellent condition when examined. Unfortunately it was lost in the mail in March, 1974 during shipment from Guelph to Philadelphia. A neotype was not designated because of the distinctness of this species. The holotype was from Massachusetts, type no. 4920. A male specimen from Edmonton, Alberta, labelled as *viridicyaneus* by two different experts (W. G. Bodenstein and E. H. Strickland) and bearing a label "compared with type" is typical and can be used as a standard for comparison. A female specimen, similarly labelled, is also in the Strickland Collection.

The holotype male of *E. connexus* Viereck was examined. It is definitely a *viridicyaneus*. The apical snout-like projection is more produced than usual and the membrane is flat, dark brown, and has a very shallow incision, but otherwise it is typical of the species. Its measurements are given in Table I. The two apical flagellomeres of each antenna are missing. It is labelled as follows: "Clark Co. Ks., May 1962 ft., F. H. Snow" (white label)/"1062" (white label)/"*Notozus connexus* Vier. Type" (red label). It is deposited in the Snow collection, University of Kansas, Lawrence.

The holotype female of *E. spinosus* Provancher was seen. After describing it as a new species Provancher noted that it was the same as *E. viridicyaneus* Norton and in his unpublished catalogue of his collection and in a later paper (Provancher, 1889) he changed the name *spinosus* to *viridicyaneus*. The specimen is a typical *viridicyaneus*. It is in excellent condition and is labelled as follows: "*Notozus viridicyaneus* Nort." (handwritten by Provancher (?) on white label with double red border)/"990" (yellow label)/"Lectotype 430, *Elampus spinosus* Provancher, Comeau 1940" (red label)/"Holotype, *Elampus spinosus* Provancher, 990, Barron 1971" (red label). It is deposited in the Provancher Collection, Université de Laval, Quebec City.

Material Examined. 263 males, 221 females. Collection dates extend from 25 January (1915, Tallac, Lake Tahoe, California) to 22 September (1961, Central Park, New York City, New York).

CANADA: ALBERTA: Edmonton; Lethbridge, Medicine Hat; Oldman River; Waterton. BRITISH COLUMBIA: Cascade; Oliver (10 mi. N. and Vaiseau

Lake); Revelstoke. MANITOBA: Aweme; Carberry; Wawboden. NEWFOUNDLAND: Aspen Brk. Camp; Buchans; Gander. ONTARIO: Belleville; Bothwell; Brighton; Constance Valley (?); Finland; Guelph; Kearney; Kings Mountain; Madoc; Ottawa (and Mer Bleue); Petawawa; Prescott, Sudbury; Toronto; Trenton. PRINCE EDWARD ISLAND: Alberton. QUEBEC: Abbotsford; Aylmer (Queen's Park); Chelsea; Gatineau Park; Harrington Lake; Hull; Kirk's Ferry; Knowlton; Meach Lake; Montreal; Old Chelsea; Ste. Térèse Island (St. John's Co.); Ville d'Anjour. SASKATCHEWAN: Prince Albert; Willows.

UNITED STATES: ALASKA: Fort Yukon. ARIZONA: Williams. CALIFORNIA: American River (Sacramento Co.); Arroyo Seco Camp (Monterey Co.); Blodgett Forest (12 mi. N.E. Georgetown) (El Dorado Co.); Bridge Creek Camp (Lassen Co.); Brockway; Buck's Lake (Plumas Co.); Camp Angelus (4 mi. S.) (San Bernardino Mountains); Carnelian Bay (Lake Tahoe); Carrville; Carson River (West Fork) (Alpine Co.); Cayton; Chester (6 mi. N.W. Bennett Creek) (Plumas Co.); Clio; Crystal Lake (Los Angeles Co.); Dardanelles (5 mi. E.); Dunsmuir (Siskiyou Co.); Elsinore (4 mi. E.) (River Co.); Fieldbrook; Hallelujah Junction (Lassen Co.); Hat Creek (Shasta Co.); Herkey Creek (San Jacinto Mountains); Huntoon Forest Camp (Mono Co.); Independence Lake (Sierra Co.); Leland Meadow (Tuolumne Co.); Lone Pine; Lost Lake, Quincy (4 mi. W.) (Plumas Co.); McCloud (5 mi. E.) (Siskiyou Co.); Millard Cyn (River Co.); Old Station (Shasta Co.); Pasadena; Red Bluff (Tehama Co.); Red Box; Rock Creek Campground (Mono Co.); Samuel Springs (Napa Co.); San Bernardino Mountains; Sattley (Sierra Co.); Sierraville (Sierra Co.); Strawberry (Tuolumne Co.); Tallac (Lake Tahoe); Trinity River Camp (Trinity Co.); Volcano (Amador Co.); Yreka (Siskiyou Co.); Yuba Pass (Sierra Co.); Mariposa Co. (County record only); Tuolumne Co. (County record only). COLORADO: Boulder (4.5 mi. N.); Manitou; Padre Canyon. CONNECTICUT: Cromwell; Stichfield; Storrs. FLORIDA: Pierce Island Homestead (Alachua Co.); Torreya State Park (Liberty Co.). GEORGIA: Atlanta. DISTRICT OF COLUMBIA: Rock Creek Park; Washington. IDAHO: Chatcolet; Deary; Moscow (and 7 mi. N.E.); Moscow Mountains. ILLINOIS: Giant City State Park (Union Co.); Willow Springs. INDIANA: Hessville. IOWA: Sioux City. KANSAS: Medora; Douglas Co. (County record only). KENTUCKY: Barren Co. (County record only). MAINE: Dryden; Jonesboro; Orono; Washington Co. (County record only). MARYLAND: Cabin John; Laurel; N.W. Branch Park (Montgomery Co.); Plummer Island (Montgomery Co.). MASSACHUSETTS: Beach Bluff; Cambridge; Lexington; Wellesley Hills. MICHIGAN: Bath; Benton Harbour; East Lansing; Galien; Gull Lake Biological Station (Kalamazoo Co.); Midland; Owosso; the following are county records only — Alger Co.; Arena Co.; Berrien Co.; Cheboygan Co.; Chippewa Co.; Clare Co.; Houghton Co.; Leelanau Co.; Manistee Co.; Midland Co.; Missaukee Co.; Monroe Co.; Ontonagon Co.; Osceola Co.; Roscommon Co.; Saginaw Co.; Wexford Co. MINNESOTA: Detroit Lakes; Anoka Co. (County record only). MISSOURI: Joplin (Jasper Co.). MONTANA: Bolton; Sula (Ravalli Co.). NEBRASKA: Sheridan Co. (County record only). NEVADA: Kingsbury (Douglas Co.); Patrick (Washoe Co.); Verdi (Washoe Co.); Yerington. NEW HAMPSHIRE: Hannover. NEW JERSEY: Lawrenceville (Mercer Co.); Princeton; Smate Hill. NEW MEXICO: Loving. NEW YORK: Brainard (Rensselaer Co.); Buffalo; Cherrytown; Cold Spring Harbour (Long Island); Flatbush (Long Island); Flushing (Long Island); Heart Lake (Essex Co.); Hempstead (Nassau Co.); Herkimer; Huntington (Kalbfleisch Research Station); Huyck Preserve; Ithaca (Cornell University Campus, Six Mile Creek, South Hill); Lewisboro (Westester Co.); Minetto; New Rochelle; New York (Central Park, Inwood Hill Park); Rensselaerville; Rochester; Tomkins Co.

(County record only). NORTH CAROLINA: Clayton; Fort Bragg (Cumberland Co.). NORTH DAKOTA: Tower City. OHIO: Barberton; Columbus. OKLAHOMA: Guthrie. OREGON: Belknap Springs (Lane Co.); Butte Falls; Corvallis; Forest Grove. PENNSYLVANIA: Avonia, Erie, Leheigh Gap; Presque Isle State Park (Erie Co.). SOUTH DAKOTA: Fort Thompson. TENNESSEE: Chimneys (Great Smoky Mountains National Park); Knox Co. (County record only). TEXAS: Taylor. UTAH: Fort Duchesne; Park City. VERMONT: Thetford. VIRGINIA: Barcroft; Falls Church Lake; Great Falls. WASHINGTON: Wawawai. WISCONSIN: Clover Leaf Lakes (Shawano Co.); Madison; Shawano Co. (County record only). WYOMING: Easterbrook; Jenny Lake.

Floral Records. *Heracleum lantanum, Melilotus alba, Lyonia ligustrina, Euphorbia* sp.

Ecology. Specimens have been caught up to 6,790 feet (Huntoon Forest Camp, Mono Co.) (California). According to Krombein (1963) this species is multivoltine in Maryland. Kurczewski (1970) suggested that it had a single generation a year at the latitude of Erie Co., Pennsylvania. He also suggested, on the basis of his collection records and records from specimens in Cornell University, that the peak abundance of *E. marginatus* in mid to late July coincided with the wane and eventual disappearance of *E. viridicyaneus*. A comparison of dates of capture of the specimens of *E. marginatus* and *E. viridicyaneus* seen in the present study is given in Table VI. The results support Kurczewski's observations on these two species in Erie Co., Pennsylvania.

A specimen of *E. viridicyaneus* in the USNM labelled "Bred from nests of *Gorytes* (s.l.) from Huntington, L.I. Cocoon March 24, 1924. em. April 30, 1924. S. C. Bridwell" is the only known host record for a North American *Elampus*. Krombein (1958, 1963) determined the host as *Psammecius (Hoplisoides) costalis* Cresson. The distribution of this host is mainly eastern North America. Since *E. viridicyaneus* occurs throughout the continent it must parasitize other species of *Psammecius* or, possibly, other genera.

Elampus marginatus (Patton)
Figs. 29, 37, 40, 41, 44, 52, 53, 62-64, 67, 70, 72, 74
Distribution map Fig. 4

Notozus marginatus Patton 1879: 66; original description.
Notozus marginatus; Aaron 1885: 219; key, redescription.
Notozus marginatus; Cresson 1887: 253; North American list.
Notozus marginatus; Provancher 1889: 220, 320; Canadian list.
Ellampus marginatus; Mocsáry 1889: 78; key, redescription quoted.
Notozus marginatus; Smith 1890: 43; New Jersey list.
Ellampus marginatus; Dalla Torre: 13; world catalogue.
Notozus marginatus; Cockerell 1898: 212; New Mexico list.
Notozus marginatus; Smith 1909: 668; New Jersey list.
Notozus marginatus; Bischoff 1913: 6; world list.
Notozus marginatus; Viereck 1916: 603; key, Connecticut list.
Notozus marginatus; Britton 1920: 322; New York list.
Notozus marginatus; Essig 1926: 869; Western North America.
Notozus marginatus; Taylor 1928: 990; New York list.
Notozus marginatus; Brimley 1938: 435; North Carolina list.
Notozus marginatus; Procter 1938: 431; Maine list.
Elampus marginatus; Procter 1946: 492; Maine list.
Elampus marginatus; Bodenstein 1951: 719; North American catalogue.
Elampus marginatus; Krombein 1958: 94; North American catalogue (supplement).

Elampus marginatus; Gibson and Carillo 1959: 200; Mexican list.
Elampus marginatus; Kurczewski 1970: 192, 196; ecology.

Description. Length: males, 4.8-7.1 mm ($\overline{X}$ = 5.8 mm, n = 10); females, 4.7-6.1 mm ($\overline{X}$ = 5.7 mm, n = 10). Other measurements in Table II. Colour extremely variable. A number of distinct colour forms were recognized and can be separated by the following key.

1. Pronotum distinctly bicolourous, black or deep violet medially, green or blue-green along margins; second abdominal tergite bicolourous, black or violet basally and medially, green or blue-green laterally .... green-black form
   Pronotum and second abdominal tergite unicolourous, black, blue, violet or green 2
2. Thorax and abdomen black .... black colour form
   Thorax and abdomen green .... green colour form
   Thorax and abdomen blue-green, blue or violet .... other colour forms

Many intermediate combinations occur and it may be difficult to separate the different forms. The distinction between blue-green, blue, and violet is rather arbitrary so these were grouped together as "other colour forms". The green-black form is typical and, with rare exceptions, is the only one occurring in the north-east from where the species was originally described. Each colour form is described separately, followed by a general description of structure.

Green-black Form. Face usually green, rarely violet in males, commonly violet in females, sometimes almost black. Front usually green or blue-green. Vertex greenish-black, sometimes green or violet, usually darker than front. Pronotum usually black medially, sometimes violet or bluish, narrowly green or blue-green anteriorly, laterally, on sides, and sometimes along posterior margin. Mesonotum and scutellum black with green, blue or violet in punctures or a green or violet tinge. Mesopleura and propodeum green, blue-green or violet. Postscutellum black on blade, green and violet in punctures basally and laterally. First tergite more or less black or violet medially, sides green to blue-green. Second tergite broadly black medially along anterior margin, violet to blue-green medially and posteriorly, green or blue-green laterally, especially at postero-lateral corners, occasionally violet. Third tergite black and violet medially at base, blue-green to green apically and laterally, often with violet reflections. Apex of snout-like projection often narrowly brown above. Apical membrane brown with a black border, sometimes completely black, occasionally yellow.

Occasionally, the pronotum may be unicolourous whereas the abdomen is bicolourous or vice versa. Such specimens are considered to belong to this colour form. The amount of black, especially on the abdomen, is extremely variable. Specimens with extensive black approach the black colour form.

Black Colour Form. Face green or blue-green with more or less violet. Front violet, sometimes black. Vertex black occasionally with violet or blue-green tinge. Genae blue-green or violet, occasionally black. Thorax black with variable amounts of green, blue or violet on mesopleura and propodeal spines and sometimes green or violet tinged on the margins of pronotum, mesonotum, scutellum, and postscutellum. Abdomen black, often with a brown underlay which may almost completely replace the black in some specimens [rufinism of Balthasar (1954)]; a deep violet tinge may be present laterally, less frequently a blue or green colour as in the green-black form. Sternites usually brown, sometimes green or blue-green.

Green Form. Face green, often with more or less gold, occasionally bronze, reflections medially, rarely with blue or violet. Front and vertex green sometimes with blue or violet along posterior margin of vertex. Genae green often with gold or brassy tinge below. Pronotum, mesonotum, and mesopleura green often with gold reflections, rarely with blue or violet reflections. Scutellum with green in punctures and black rims. Some specimens had considerable copper on the mesonotum. Propodeum green, often with blue or violet tinge. Abdomen green, sometimes with gold reflections, less often with a bluish tinge.

Other Colour Forms. These are similar to the green form but the green is replaced by blue, blue-green or violet, without gold reflections. Various shades of blue are most common and violet appears least often.

Structure. Scapal basin usually striate, striations rather wavy, uneven, indistinct or distinct, and straight or curved, often becoming rugose laterally and below. Front with distinct, round, medium to large, contiguous to densely spaced punctures. Pronotum with round, usually indistinct, medium, densely spaced punctures, often clumped medially. Tarsal claws with three inner teeth (Figs. 37, 67). Fore femora of males rounded ventrally at base (Fig. 41), more or less projecting in females (Fig. 40). Wings clear basally, faintly to distinctly brown beyond venation. Punctation of thorax and abdomen similar to *E. nitidus nitidus*. Shape of abdomen, especially third tergite, variable, relatively long and narrow to relatively short and broad. Lateral margins bisinuate. Third tergite with margins convex as seen from above. Apical snout-like projection distinct, readily visible from the side or from above with a few exceptions. Apical truncation with incision less than one-half height of apical truncation (Figs. 29, 74), occasionally deep, not as shallow as in *E. hyalinus* except in some southern specimens. Male genitalia as in Figure 44. Measurements in Table II.

Variation. The most noticeable variation is in colour as described above. The green-black form and the black form appear to be a sub-group of their own and the green form and other colour forms make up another sub-group. Structurally, no consistent differences were found among the different colour forms. Similarly, no consistent, structural differences were found between the green form of *marginatus* and *E. nitidus nitidus*. Since there is close similarity among specimens of the latter without copper colour and green specimens of the former it could be argued that they form one species. However, until information on the biology of the different colour forms of these two species is available and perhaps shows that they are the same they will be considered as separate. It could be argued that *E. nitidus nitidus* and *marginatus* form one species as the computer analysis separated them only partially, thus showing their close relationship. The separation is sufficient, however, to warrant keeping the two as species distinct (Table VII). The geographical distribution of *E. nitidus nitidus* and the green form of *marginatus* is somewhat different (Figs. 3, 4). There is also a tendency for geographical separation of the other colour forms of *marginatus*. The black form is restricted essentially to British Columbia, Washington, Oregon, and Idaho. The green-black form is mainly north-eastern and northern. The green form and the other colour forms are mainly western and southern. However, with the possible exception of the black colour form, the distributions of each form are throughout North America and they all overlap broadly.

There is considerable variation in the shape of the abdomen and in size of the whole insect. The black colour form tends to have a relatively narrow body, and the green colour form has a robust appearance somewhat similar to that of *E. viridicyaneus* in some instances. There is great variation in the shape of the third tergite, which may be relatively broad and short or relatively long and narrow, and in the distinctness of the apical snout-like projection. However, the variation is subtle and apparently continuous and no constant differences could be found among different populations.

A number of specimens from Arizona, New Mexico, and Mexico have dense to contiguous punctures on the abdomen and the density of punctures on the remainder of the body is greater than normal. The punctures on the third tergite also average larger than normal, being distinct, angular, medium rather than indistinct and small), contiguous and clearly differentiated from the small basal punctures. In these specimens the apical truncation usually has a very shallow incision as in *E. hyalinus*. A similar situation with regard to punctation density, shape of apical truncation, and geographical distribution occurs in *E. nitidus nitidus* as discussed above.

E. marginatus is an extremely variable, widespread, and relatively common species as considered here. In eastern North America it is relatively uniform in colour and structure but in western North America it becomes relatively more complex. Possibly a number of closely related species actually occur there and may be distinguished eventually.

Diagnosis. The three inner teeth of the tarsal claw, the striate scapal basin (not as distinctly striate as in *viridicyaneus),* the distinctly visible apical snout with an apical truncation having an incision less than half the height of the truncation and the characteristic colours of the different colour forms are diagnostic.

A number of specimens appear very similar to small specimens of *viridicyaneus*. Some specimens of the green colour form may be confused with green *E. nitidus nitidus* but the strongly contrasting colour of the abdomen and propodeum of the latter species should distinguish them.

Type Material. Patton (1879) described *E. marginatus* from a single specimen from Waterbury, Connecticut. His collection, including the type, was destroyed (Britton and Howard, 1921). The original description does not give the sex but mentions "face . . . with a violet reflection" and "anterior femora angulated beneath", thus indicating that the original specimen was likely a female. Of the seven specimens seen from Connecticut in the present study, one was chosen as neotype. It is a female in good condition and is labelled as follows: "Conn. Riverbank, E. Hartford, Ct., Aug. 18, 1947, Howard E. Evans./CORN". A label indicating the sex and a red neotype label "Neotype *Notozus marginatus* Patton, 1879, Designated by Huber, 1975" were added. The neotype is deposited at Cornell University, Ithaca. The specimen agrees fairly well with the original description and is a green-black colour form. Its measurements are given in Table I.

Material Examined. 467 males, 657 females (black form, 22 ♂♂, 17 ♀♀; green form 70 ♂♂, 100 ♀♀; green-black form, 160 ♂♂, 240 ♀♀; other forms, 215 ♂♂, 300 ♀♀). Collection dates extend from 26 March (Wood Lake, Tulare Co., California) to 22 October (Austin, Texas).

Colour forms are indicated after each collection locality by the following symbols: B black form, G green form, O other forms, T typical green-black form.

CANADA: ALBERTA: Banff (G); Beaverlodge (T); Bilby (T); Brooks (O); Clyde (G); Drumheller (T); Edmonton (G, T, O); Empress (T); Fort McMurray (G, T); Grande Prairie (G, T); Grimshaw (G, T); High Prairie (T); Lethbridge (G, T); Lundbreck (G); Medicine Hat (T); Onefour (T); Red Deer (T); Rycroft (T, O); Steveville (G); Wabamun (T); Wainwright (T). BRITISH

COLUMBIA: Bowser (T); Cheekye (B); Chilcotin (G, T, O); Clinton (B); Grand Forks (O); Hargreaves (Soda Creek) (O); Hat Creek (T); Hatzic Lake (B); Howser (Selkirk Mountains) (B); Kamloops (G, T, O); Kaslo (B); Keremeos (O); Lytton (6 mi. N.) (O); MacGillivary Creek Game Reserve (Chilliwack) (B); Manning Park (G); Milner (B); Mission City (B); Nelson (T); Nicola (T, O); Oliver (G, T, O); Osoyoos (G, O); Pavilion (T); Pavilion Lake (T); Princeton (4 mi. W.) (G); Quesnel (B, T, O); Richter Pass (Osoyoos) (G, T, O); Rolla (T); Salmon Arm (B); Salmon River (Glenemma) (B, T); Sicamous (T, O); Soda Creek (B, T); Stoner (O); Summerland (O); Terrace (B); Vaiseau Lake (Oliver) (G); Vernon (G, O); Victoria (G); Walhachin (G, T); Westwick Lake (Cariboo) (G, T); White Lake (Oliver) (G). MANITOBA: Aweme (T); Carberry (O); Gillam (T); Ninette (T); Souris (T); The Pas (T); Virden (T); Waboden (T); Winnipeg (T). NEW BRUNSWICK: Fredericton (Acadia Experimental Station) (T); Nerepis (T). NOVA SCOTIA: Kentville (T); Truro (T). ONTARIO: Bancroft (T); Chatterton (T); Coniston (T); Dorset (T); Harrow (T); Hepworth (T); Kearney (T); Kendal (T); Kincardine (O); London (T); Madoc (Crystal Beach) (T); Midland (T); Muskoka (T); New Glasgow (T); Ottawa (T); Primrose (T); Salines (T); Shetland (T); Strathroy (T); Swansea (T); Toronto (T); Tweed (T). PRINCE EDWARD ISLAND: Bradley Beach National Park. QUEBEC: Brysonville (5 mi. E.) (T); Duchesnay (T); Forestville (B); Fort Coulonge (T, O); Hemmingford (T); Knowlton (T); Ladysmith (T); Megantic (T); Richmond (T); Shawville (T); Ste. Anne de Bellevue (T). SASKATCHEWAN: Assiniboia (T, O); Big River (G, T, O); Canora (T); Christopher Lake (G, T); Elbow (G, T); Lebret (T); Lumsden (T); Melfort (T); Prince Albert (G, T); Saskatoon (G, T); Stockholm (T); White Fox (T).

UNITED STATES: ALABAMA: Montgomery (G). ALASKA: Burkville (G); Fairbanks (T). ARIZONA: Buckeye (5 mi. S.) (G); Continental (G); Douglas (San Bernardino Ranch and 3 mi. N.) (O); Flagstaff (G, O); Florence (O); New River (10 mi. W.) (G); Oak Creek Canyon (O); Sacaton (O); San Francisco Mountains (O); White Mountains (O). CALIFORNIA: Almanor Dam (1 mi. W.) (Plumas Co.) (T, O); Alpine Creek (Tahoe) (O); Bairsden (O); Barton Flats (San Bernardino Co.) (G); Big Flat, Coffee Creek (Trinity Co.) (O); Big Sandy Flat (Madera Co.) (O); Boca (T); Bridge Creek Camp (Lassen Co.) (O); Bridgeport (Mono Co.) (O); Buck's Lake (Plumas Co.) (O); Carnelian Bay (Lake Tahoe) (O); Carville (Trinity Co.) (O); Claremont (G, O); Coffee Creek Research Station (10 mi. N.) (Trinity Co.) (O); Cottonwood Creek (Mono Co.) (O); Dardanelle (G, O); Davis (T, O); Davis Creek (Madoc Co.) (T); Dos Pasos (O); Echo Lake (El Dorado Co.) (O); El Centro (G); Felton (O); Fresno (O); Fuller Lake (Nevada Co.) (O); Glennville (O); Gold Lake (Sierra Co.) (O); Grapevine (O); Green Mountain (Madoc Co.) (O); Hallelujah Junction (Lassen Co.) (O); Hat Creek (Shasta Co.) (T, O); Hat Lake (Lassen Co.) (O); Hemet (G, O); Hesperia (G); Holtville (and 2.5 mi. E.) (G); Hope Valley (Alpine Co.) (G, O); Huntington Lake (Fresno Co.) (T, O); Independence Lake (Sierra Co.) (O); Indio (Keosegan Ranch) (G, O); Jackson Lake (Nevada Co.) (O); Kennedy Meadow (T, O); Lassen Park (Shasta Co.) (T); Lake Tahoe (O); Lindsay (O); Little Lake (Inyo Co.) (O); Little Rock (1 mi. W.) (G); Lone Pine (O); Los Angeles (4 mi. E.) (O); Mather (T); Meyers (T) (and 2 mi. S.) (G); Mira Loma (1 mi. N.) (O); Montebello (O); Moose Camp (Shasta Co.) (O); Mountain Meadow Ranch, Coffee Creek (Trinity Co.) (O); Newark (O); Niles (O); Oasis (O); Olancha (O); Old Station (Shasta Co.) (O); Onion Valley (Plumas Co.) (O); Palm Springs (G, O); Palo Verde (3 mi. S. and 2 mi. W.) (O); Patterson (T); Placerville (O); Pleasanton (O); Red Lake (1.5 mi. N.E.) (Alpine Co.) (G, O); Ripley (O); Riverside (G, O); Russell Valley

(Nevada Co.) (T); Sacramento (T) (and 7 mi. N.) (O); Sagehen Creek (near Hobart Mills) (Nevada Co.) (G, O); San Diego (G); San Gabriel River (Los Angeles Co.) (G); Sattley (O); Sierraville (O); Silver Lake (El Dorado Co.) (O); Smith Meadow (9 mi. Canyon) (5 mi. E.) (Tulare Co.) (O); Spaulding (G); Strawberry (G, O); Summit Camp (Lassen Co.) (O); Susan River Camp (Lassen Co.) (T, O); Tallac Lake Tahoe (G); Tamarack Lake (G); Thermal (G); Thousand Palms (O); Three Rivers (O); Tracey (T, O); Tragedy Springs (6 mi. W.) (Amador Co.) (O); Vail Lake (Riverside Co.) (G); Volcano (O); Westley (O); Westwood (O); White Mountains (and Blanco's Corral) (Mono Co.) (O); Woodlake (Tulare Co.) (O); Yosemite National Park (G, O) (and Crane Flat) (O); Yuba Pass (Sierra Co.) (O). The following are county records only: Los Angeles Co. (O); Plumas Co. (O); San Bernardino Co. (0); Shasta Co. (T); Siskiyou Co. (O). COLORADO: Boulder (T); Buena Vista (G); Clark (O); Florissant (G); Estes Park (G, T, O); Golden (4 mi. S.W.) (T); Gothic (Elk Mountains) (O); Idaho Springs (3 and 5 mi. S.W.); Jefferson (G); Kremmling (G); Lyons (O); Mount Evans (Doolittle Ranch) (T); Nunn (Owl Creek) (G); Pine Cliffe (G); Poudre River Canyon (T); State Bridge (O); Westcliffe (O). CONNECTICUT: E. Hartford (and riverbank) (T); New Haven. DISTRICT OF COLUMBIA: Washington (G, O). FLORIDA: Arcadia (T). GEORGIA: Chattooga River (Addie Branch, East Fork) (T); Medonough (G); Toccoa (G); Warwoman Creek (Rabun Co.). IDAHO: Bovill (G); Caldwell (O); Cambridge (8 mi. S.) (O); Challis (O); Filer (O); Glenns Ferry (T); Granite (G); Hagerman (O); Jerome (O); Kimberly (O); Lake Fork (O); Paris (O); Potlach (O); Rock Creek Research Station (Minidoka National Forest) (O); Tuttle (T, O); Twin Falls (B, O). ILLINOIS: Carbondale (G); Meredosia (G). IOWA: Pleasant Valley (T); Sioux City (T, O); Sgts. Bluff (?) (O). KANSAS: Manhattan (O); Sumner Co. (County record only) (O). LOUISIANA: (State record only). MAINE: Dryden (T); Salisbury Cove (T). MARYLAND: Crownsville (G); Oakland (G). MASSACHUSETTS: Bedford (T); Lexington (O); Woods Hole (T). MICHIGAN: Atlanta (T); Benton Harbour (T); Block Lake (T); Cedarville (T); Detroit (T); Dexter (T); Douglas Lake (T); East Lansing (T); Escanaba (T); Gull Lake Biological Research Station (Kalamazoo Co.) (T); Kalamazoo (T); Marquette (T); Sleeping Bear (G); Van Riper State Park (Marquette Co.) (T); Welderness Park (Emmet Co.) (T). The following are county records only: Cheboygan Co. (G); Delta Co. (T); Dickinson Co. (T); Ingham Co. (T); Kalkasha Co. (T); Muskegon Co. (T); Osceola Co. (T); Wexford Co. (T). MINNESOTA: St. Peter (T). MONTANA: Jefferson Island (T). NEBRASKA: Oshkosh (8 mi. N.E.) (O). NEVADA: Beatty (A); Beowawe (O); Kingsbury (O); Mount Rose (summit) (Washoe Co.) (O); Orovada (Patrick Co.) (T, O); Wine Cup Ranch (Elko Co.) (O); Winnemucca (G); Yerington (O). NEW HAMPSHIRE: Durham (T); Etna (T); Gorham (T); Lancaster (T); Meredith (T). NEW JERSEY: Englewood (T); Riverton (G). NEW MEXICO: Alamagordo (O); Albuquerque (G); Animas (O); Cloudcroft (T, O); Hot Springs (Truth or Consequences) (O); Jemez Springs (G); Las Cruces (O); Loving (G); Pinedale (O); Rodeo (G); White Sands National Monument (Otero Co.) (G). NEW YORK: Adiron Mountains (Axton) (T); Allegheny State Park (T); Cherrytown (T); Flatbush (T); Flushing (T); Ithaca (T); Kalbfleisch Research Station (Huntingdon, L.I.) (T); Karner (T); Lake Wacabuc (T); Lynbrook (T); N. Fairhaven (T); Pocantin Hills (T); Potsdam (T); Powder Mills (T); Riverhead (Long Island) (T); Sloansville (B, T); Saint Mary's Pond (Oswego Co.) (T); Long Island (County record only). NORTH CAROLINA: Highlands (and Horse Cove) (T); Holly Shelter (G); Jacksonville (G); Nance (?) (G); Raleigh (G). NORTH DAKOTA: Dickinson (O); Elbowoods (T); Tower City (T); Walcott (11 mi. W.) (G). OKLAHOMA: Lake Texoma (2 mi.

E. Wallis) (G); Lawton (O); Leflore (O). OREGON: Catherine Creek State Park (Union Co.) (O); Corvallis (B, G, O); Lake of the Woods (O); Santiam Pass (O); Siskiyou (G); Tall Gate (Blue Mountain) (O). PENNSYLVANIA: Lingelstown (T); Pittsburg (T); Presque Isle State Park (Erie Co.) (T); Wintergreen Gorge (1 mi. S. Erie) (T). SOUTH CAROLINA: Seneca (G). SOUTH DAKOTA: Custer (G); Hecla (G); Warren Woods (White) (T). TEXAS: Austin (G); Imperial (G); Mason (12 mi. N.) (O). UTAH: Cedar Breaks (O); Cedar Breaks National Monument (10 mi. N.) (Iron Co.) (G, O); Duck Creek Camp (Kane Co.) (G, O); Echo (Glenwood Co.) (O); Green Lake (Daggett Co.) (G); Greenriver(O); Leeds(O); Lehi(O); Logan-Cache Airport(1 mi. W). (Cache Co.) (O): Lost Creek, Uinta Mountains (O); Monte Cristo (O); Navajo Lake (O); Panguitch Lake (Garfield Co.) (O); Saint George (O); Topaz (O). VERMONT: E. Thetford (T); Jamaica (T); Wildham Co. (County record only) (T); Windsor (County record only) (T). WASHINGTON: Almota (O); Coulee City (O); Easton (G); Grand Coulee Dam (Harrah Co.) (O); Irrigation Experimental Station (Benton Co.) (O); Lake Chelan (Chelan Co.) (B); Lind (O); Moses Lake (O); O'Sullivan Dam (Grant Co.) (O); Othello (2 mi. N.) (O); Palouse (O); Pullman (G, T, O); Quincy (O); Roy (B); Spanaway (B, T); Toppenish (O); Uniontown (G); Vancouver (O); Wawawai (O); White Swan (G); Yakima (O). WEST VIRGINIA: Lost River State Park (Hardy Co.) (T). WISCONSIN: Madeline Lake (Oneida Co.) (T); Mountain (G); Razorback Lake (G); Shawano Co. (County record only) (T). WYOMING: Bighorn National Forest (Tie Hack Campground) (Johnston Co.) (G); Green River (G); Jackson (6 mi. N.) (G, O); Jackson Hole Research Station and Jenny Lake (Grand Teuton National Park) (G); Laramie (40 mi. N.E.); Little America (22 mi. W.) (G); Newcastle (6 mi. N.W.) (O); Yellowstone National Park (Roosevelt Lodge and Turbid Lake) (O).

MEXICO: Escalon (12 mi. N.) (Chihuahua) (O).

Floral Records. *Beta vulgaris, Iva axillaris, Lepidium thurberi, Medicago sativa, Melilotus alba, N(orta)? altissima, Polygonella polygama, Solanum tuberosum, Trifolium pratense, Vigna sinensis, Actinea, Chrysothamnus, Euphorbia, Helianthus, Populus, Symphoricarpos, Trifolium, Carduus.*

Biology. Specimens of *E. marginatus* have been collected up to 10,000 feet (10 mi. N. Cedar Breaks National Monument, Iron Co., Utah).

Kurczewski (1970) collected *marginatus* on sand and on gravel at edges of woodlands. The present author has seen specimens being collected near a stand of young poplar on sand dunes covered with sparse, low-growing vegetation at Hepworth, Ontario. Records from five pinned specimens seen in this study indicate that they were collected on sand dunes or dune associations. Collection dates of *marginatus* seen in the present study are given in Table VI. The somewhat later flight period of *marginatus* compared to *viridicyaneus* is evident although the different geographical areas covered do not make the results strictly comparable. No hosts have yet been recorded.

Elampus aaroni Bodenstein
Figs. 34, 35
Distribution map Fig. 5

Notozus productus Aaron 1885: 219; key, original description (nec Dahlbom 1854: 44).
Elampus productus; Mocsáry 1889: 78; original description and key quoted.
Ellampus productus; Dalla Torre 1892: 14; world catalogue.
Notozus productus; Bischoff 1913: 6; world list.
Notozus productus; Cresson 1928: 30; type material.

Notozus productus; Brimley 1938: 435; North Carolina list.
Elampus productus; Bodenstein 1951: 719; North American catalogue.
Elampus aaroni Bodenstein 1951: 719; new name, North American catalogue.

Redescription of Male Paratype. Length 5.3 mm. Other measurements in Table I. Face bright green with gold reflections. Front, genae, and vertex green with violet reflections in ocellar triangle and posterior margin of vertex. Thorax green with a black tinge on pronotum and violet reflections on pronotum and laterally on mesonotum. Posterior part of scutellum and postscutellar blade dark brown. Wings hyaline with a faint brownish tinge beyond venation of forewing. Abdomen green with a faint blue tinge and scattered violet reflections and a distinct brown underlay, especially laterally. Apical membrane brown with a similarly coloured band above apical snout-like projection, extending laterally in groove above the apical, lateral sinuation.

Structure and punctation very similar to *marginatus* except for the abdomen. Scapal basin with wavy, rather indistinct striations. Front with distinct, medium, mostly contiguous punctures becoming smaller posteriorly. Pronotum with distinct, medium, mostly contiguous punctures. First tergite with mostly minute to small, moderately spaced punctures. Second tergite with small, oval to elongate, densely spaced punctures medially, contiguous and less distinct laterally, giving an almost rugose appearance. Third tergite with small, oval, densely spaced to contiguous punctures basally becoming medium and less distinct apically. Apical truncation as in Figure 34. Ratio of width of truncation to width of third tergite, 0.38. Tarsal claws with three inner teeth. Male genitalia as in Figure 45 and measurements in Table I.

Female Paratypes. Length 5.1-6.1 mm (n = 3). Other measurements in Table II. Ratio of width of truncation to width of third tergite: m 0.34, S.D. 0.03 (n = 3).

Variation: Apart from slight size differences there is very little variation among the four paratypes. A few specimens which were placed tentatively under this species differ in colour, size, and distinctness of the punctation of the abdomen.

Diagnosis. The relatively broad apical truncation in relation to the width of the third tergite ($\frac{W_t}{W_{III}}$ = 0.32 approximately) is considered as diagnostic. In addition, thc relatively evenly tapering sides of the third tergite (compared to the usually convex sides in other species) may help to distinguish this species but this character is variable and subjective.

Type Material. Aaron (1885) described *productus* on the basis of five specimens from Montana. Four of these (one male, three females) were examined. they are in fairly good condition. Both antennae of one specimen and one antennae of two other specimens are missing. The right fore and hind wing of one specimen are also missing. Each specimen is labelled "Montana"/"3 teeth" (pink label/ "Paratype 4913" (blue label). A label indicating sex was added to each specimen. One specimen also bears a white label *"Notozus productus* Aaron". Aaron did not designate a holotype. However, Cresson (presumably) chose one specimen as holotype and labelled the others as paratypes. The "holotype" must be considered as a lectotype. The type series is deposited in the Academy of Natural Sciences, Philadelphia.

Aaron (1885), in his key to North American species, distinguishes this species on the basis of the shape of the abdomen and third abdominal tergite as "abdomen longer and narrower, the snout-like projection larger in relation to the third segment than in other species" compared to "abdomen, in shape, ordinary; about as long as wide . . .; the snout-like projection also median in size." Actually, the abdomen only appears longer due to the odd shape of the third tergite but, by measurement, it is the same size in relation to the size of the thorax as in *marginatus* or similar species. However, the shape and proportions of the third tergite are important. A number of specimens were placed tentatively under *aaroni* on the basis of the evenly tapering sides of the third tergite. These specimens had separate, distinct punctures on the abdomen and varied in colour from bright green to blue-green, violet or bi-coloured (as in the green-black form of *marginatus).* Measurements of the abdomen revealed that the apical truncation was not much larger in relation to the third tergite than in other species. Ratios for these specimens were: m = 0.26, S.D. = 0.02, min. = 0.23, max. = 0.28 (n = 13) compared to m = 0.24 (n = 131) for *marginatus* and m = 0.33 (n = 4) for the types of *aaroni*. One other specimen (from Casselton, North Dakota) had a ratio of 0.38 and on this basis was considered to be *aaroni* whereas the others with a ratio below 0.30 were not considered to be *aaroni*. No other useful characters were found to identify this species. *E. versicolor* also has a $\frac{W_t}{W_{III}}$ ratio greater than 0.32 and the types of the two species are fairly similar in structure although some of the measurements are not (Table I). Both species appear to have a relatively rugose abdomen but this is less pronounced in *aaroni*. On the basis of the relative width of the apical truncation compared to the third tergite, *aaroni* could be synonomized with *versicolor*. However, because of the few, rather arbitrary and poor characteristics used to identify these two species and to separate them from others, they will be considered as separate.

Species incertae sedis
Elampus versicolor Norton
Fig. 35
Distribution map Fig. 5

Elampus versicolor Norton 1879: 235; key, original description.
Notozus versicolor; Aaron 1885: 218; key, redescription.
Ellampus versicolor; Mocsáry 1889: 77: key and redescription quoted.
Ellampus versicolor; Dalla Torre 1892: 18; world catalogue.
Notozus versicolor; Cockerell 1898: 212; New Mexico list.
Notozus versicolor; Bischoff 1913: 7; world list.
Elampus versicolor; Cresson 1928: 30; type material.
Elampus versicolor; Bodenstein 1951: 719; North American catalogue.

Redescription of Holotype Male. Length 6.2 mm. Other measurements in Table I. Head green with violet tinge on scapal basin, clypeus, in ocellar triangle, posteriorly on vertex and genae. Thorax mainly violet with green anteriorly and laterally on pronotum and mesonotum, below on mesopleura, and laterally on propodeum. Blade of postscutellum and part of scutellum, black. Wings hyaline basally, apices missing (presumably brownish). First tergite green basally around black basal pit, a narrow, longitudinal streak medially, blue-violet elsewhere. Second tergite blue-violet with a narrow, longitudinal, blue-green, median streak fading apically. Third tergite blue-violet, distinctly bright yellow at apex of snout-like projection. Apical membrane bright yellow with distinct, contrasting dark brown border. Sternites violet to blue-green.

Scapal basin indistinctly striate, becoming rugose laterally. Front with distinct, medium, contiguous punctures. Pronotum with medium to large, mostly contiguous punctures as large as on the scutellum. Base of fore femora evenly rounded below. Tarsal claws with three inner teeth. First tergite with small, round, densely spaced punctures medially near posterior margin, sparsely spaced sub-laterally, indistinct, round to elongate, and larger laterally. Second tergite appearing much more rugose than the first, punctures small, very indistinct, dense, XX-shaped and larger, more distinct laterally. Punctures on third tergite more distinct than those on second, oval, medium, densely spaced to contiguous, still appearing somewhat rugose. Ratio of width of apical truncation to width of third tergite, 0.34. Apical truncation as in Figure 35.

Variation. Only one specimen was seen which agreed closely with the type except for a few, minor differences. The metallic colour was generally more intense. The colour of the apical membrane was brown with a narrow, black border and a very narrow, but distinct, brown border above the apex of the apical snout-like projection. Measurements are given in Table II. The ratio of the width of the apical truncation to the width of the third tergite is 0.33.

A number of other specimens were seen which had the characteristic yellow or brown membrane and apex of the snout-like projection contrasting sharply with the colour of the remainder of the third tergite, as given by Aaron (1885) to distinguish *versicolor* from other species of *Elampus*. Structurally, however, these specimens were similar to *marginatus*.

Diagnosis. The relatively broad apical truncation in relation to the width of the third tergite (0.33) is considered as diagnostic. The colour difference given in the key to separate *versicolor* from *aaroni* likely only applies to the few specimens seen in the present study and will eventually prove to be useless. The roughened tergites which do not appear distinctly punctate and the rather broad, distinct band of brown or yellow on the apex of the snout-like projection may help to distinguish this species but these characteristics are subjective and also occur in other species.

Type Material. Norton (1879) described the species on the basis of one specimen from Dakota. The type was examined and was in good condition except for the forewings, one of which was missing and the other missing the apex. The type was lost in the mail when being returned to the National Academy of Sciences, Philadelphia. Its measurements are given in Table I. No neotype was designated.

Discussion. The specific status of *E. versicolor* is uncertain. On the basis of the original description there are four possible characteristics for separating it from other species. These are (1) the wings which are only "faintly clouded apically", (2) the yellow membrane and yellow band on the snout-like projection, (3) the yellow tarsi, and (4) the abdomen with a roughened surface but without distinct punctures. Norton (1879) used the characteristics "tergum roughened, without distinct punctures; wings hyaline" to separate *versicolor* from *viridicyaneus,* the only other species of the group keyed under this section B *(Elampus).* Aaron (1885) compared the holotype with a specimen from Montana which he considered as being *versicolor* and noted differences in colour and in distinctness of punctation on the abdomen. This specimen was seen but is missing the abdomen. In his key to North American species, Aaron used the diagnostic characteristic "the snout-like projection at abdominal apex with its closing membrane semi-transparent brown, and with a band of the same colour before its apical margin" to separate *versicolor* from other species in which the closing membrane was "black, concoloured before its apical margin".

The roughened appearance of the punctation of the tergites of the type specimen may be abnormal and an extreme form of a densely or contiguously punctured abdomen. Only one other specimen (discussed above) was seen which had similar punctation. The punctation of the type series of *aaroni* approaches that of *versicolor* but is more distinct. The characteristics of the wing colour and colour of the tarsi are vairable, shared by other species, and subjective. Similarly, the colour of the apical membrane and apex of the snout-like projection, used by Aaron for distinguishing *versicolor,* are variable and subjective. Two series of specimens from Bard, California and Yuma, Arizona, respectively, had membrane colours ranging from bright yellow to brown with similarly coloured bands on the apical snout-like projection. These specimens, and a number of similarly coloured specimens identified as *versicolor* by previous workers, had wing colour and punctation of the abdomen as in *marginatus,* to which they likely belong.

One characteristic of *versicolor,* not mentioned by Norton, is the relatively wide apical truncation compared to the width of the third tergite. This characteristic was selected in the present study as being diagnostic for *versicolor* although *E. aaroni* also shares it. Colour differences were used to separate these two species in the key but may prove to be inadequate. Unfortunately, because the type was lost it cannot be re-examined for further characteristics which might solve the problem of the specific status of *versicolor*. The specimen discussed under Variation (above) which could serve as a neotype was collected at Florissant, Colorado and is deposited in the United States National Museum. At present, it is not designated as a neotype in the hope that further information or specimens will become available for study, or the type will be found.

Conclusions

The distribution of species of *Elampus* in North America is similar to the distribution of *Parnopes* (Telford, 1964), *Chrysura* (Horning, 1969) and *Omalus* (Bohart and Campos, 1960) in that most species occur in the west or south-west. In the north-east only two species of *Elampus* — *E. marginatus* and *E. viridicyaneus,* are collected commonly. *E. nitidus nitidus* is common in the west. *E. aaroni* and *E. versicolor* are only known from their types and a few possible additional specimens from Montana, "Dacota", and Colorado. The remaining species occur mainly in the south-west. A few possible, additional species were segregated but are not described or named herein. These possible species occur in the south-west from Texas to California and more material from this area is needed to evaluate them properly. They would key out to *E. marginatus*. On the basis of characteristics such as the shape of the apical truncation, the number of inner teeth in each tarsal claw, and the relative lengths of the digiti, cuspides, and parameres of the male genitalia, and on geographical distribution, *E. rotundus,* and to a lesser extent, *E. hyalinus,* are related to South American species whereas the other North American species appear to be more closely related to Palaearctic species.

Discriminant analysis of eight measurements and ratios of males and females of six of the eight taxa described in this paper *(E. versicolor* and *E. aaroni* excluded) showed that the taxa could be distinguished from each other with a high degree of accuracy using quantitative data alone (Table VII). However, the samples on which this analysis was based were relatively small and biased in that only specimens which were considered typical of each taxon, and which could be distinguished readily using qualitative characteristics only, were chosen for measurement. Further statistical studies using larger samples and including specimens or populations which cannot be placed readily in one or another taxon may be useful in clarifying species limits especially in *E. marginatus*. Biological studies and knowledge of hosts would be particularly useful in helping to clarify the relationships in some species.

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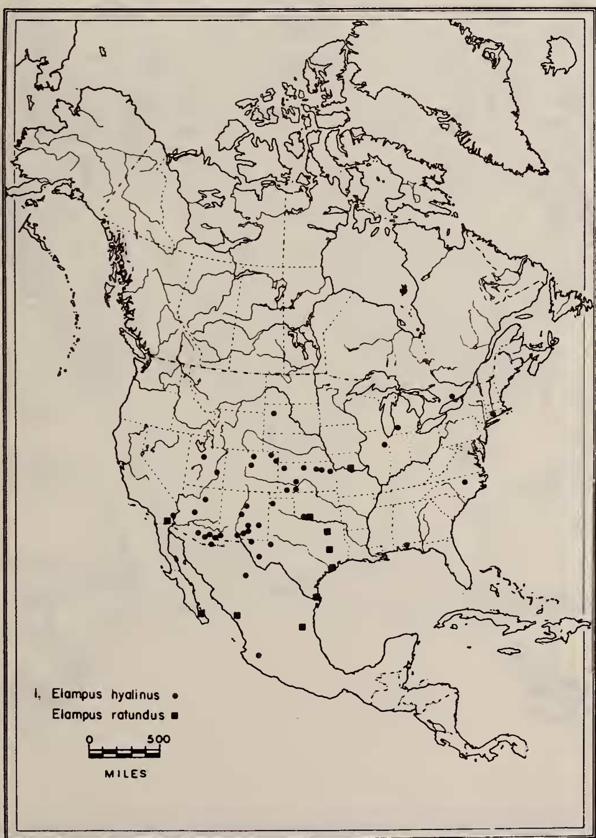

Fig. 1. Distribution of *Elampus hyalinus* (Aaron) and *E. rotundus* sp. nov. (Hymenoptera, Chrysididae).

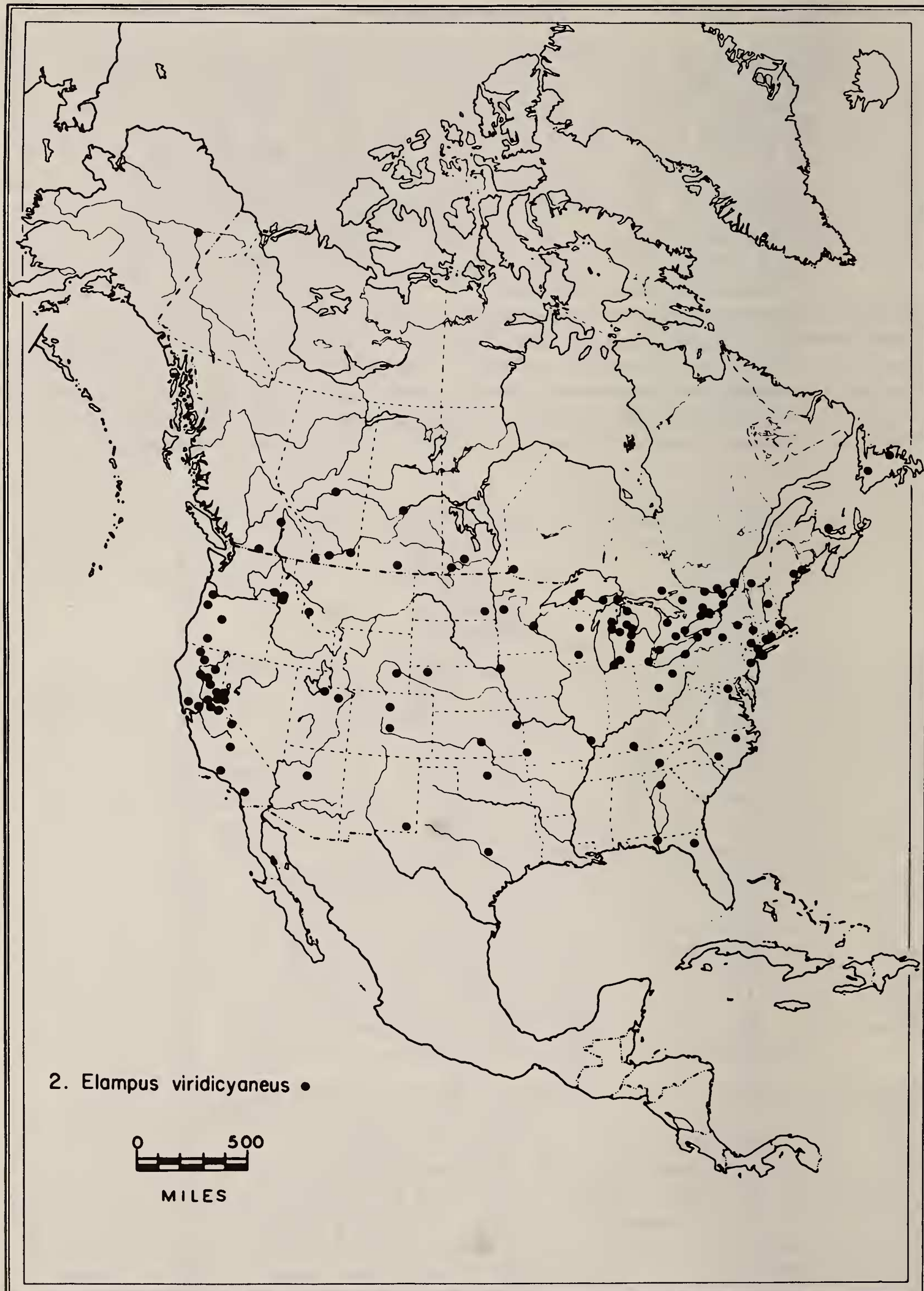

FIGURE 2. Distribution of *Elampus viridicyaneus* Norton (Hymenoptera, Chrysididae).

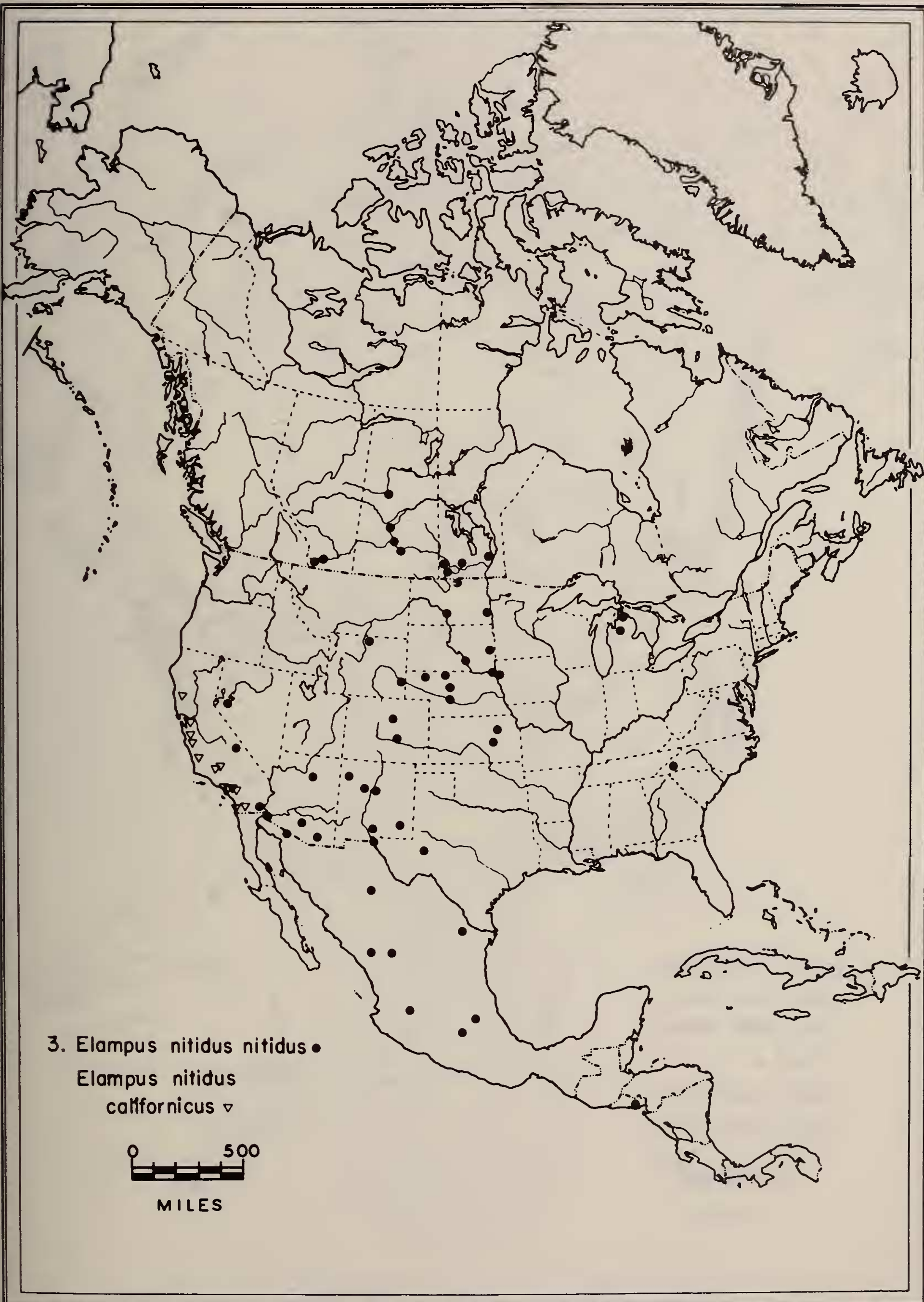

FIGURE 3. Distribution of *Elampus nitidus nitidus* (Aaron) and *E. nitidus californicus* subsp. nov. (Hymenoptera, Chrysididae).

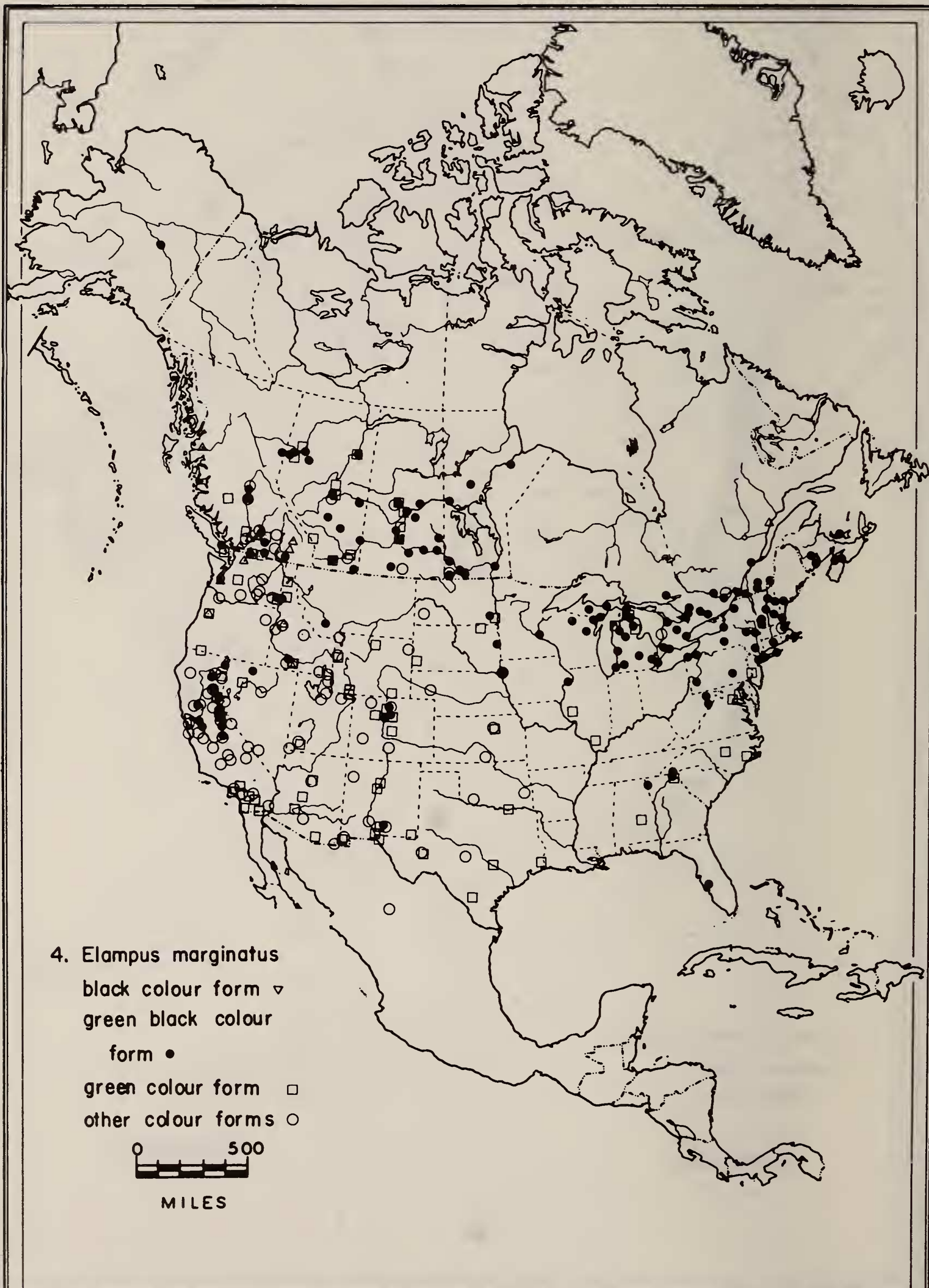

FIGURE 4. Distribution of the colour forms of *Elampus marginatus* (Patton) Hymenoptera, Chrysididae).

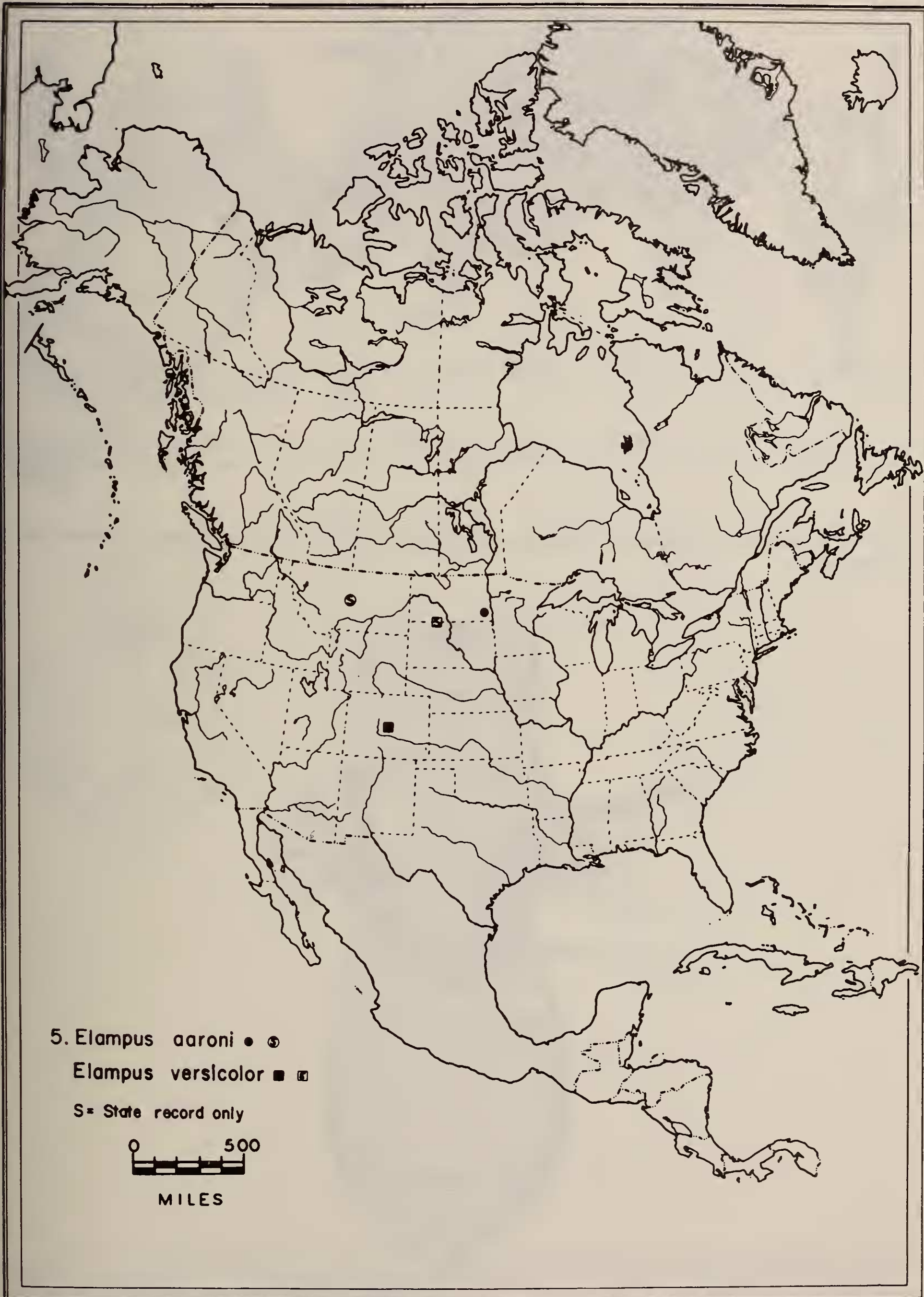

FIGURE 5. Distribution of *Elampus aaroni* Bodenstein and *E. versicolor* Norton (Hymenoptera, Chrysididae).

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FIGURE 6. Habitus drawing of *Elampus viridicyaneus* Norton (Hymenoptera, Chrysididae). Lateral view.

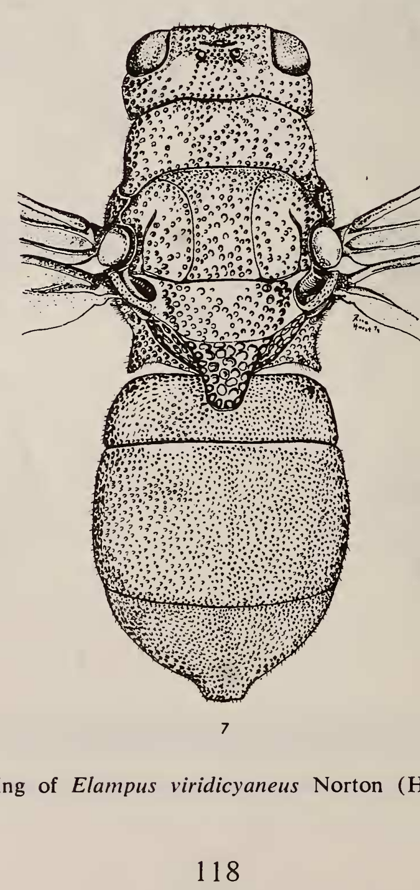

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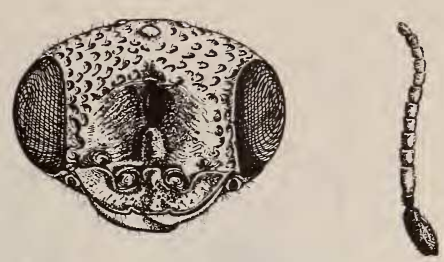
FIGURE 7. Habitus drawing of *Elampus viridicyaneus* Norton (Hymenoptera, Chrysididae). Dorsal view.

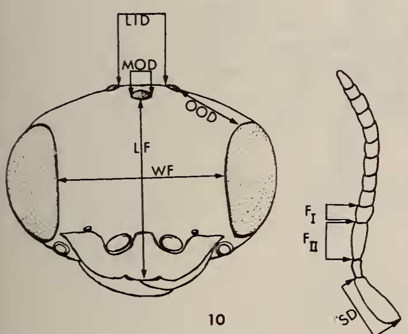
8



9

FIGURE 8. Drawing of head and antenna of female *Elampus viridicyaneus* Norton (Hymenoptera, Chrysididae). Front view.

FIGURE 9. Drawing of head and antenna of male *Elampus viridicyaneus* Norton (Hymenoptera, Chrysididae). Front view.



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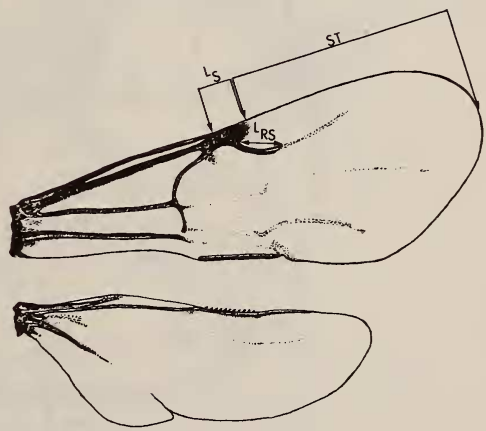
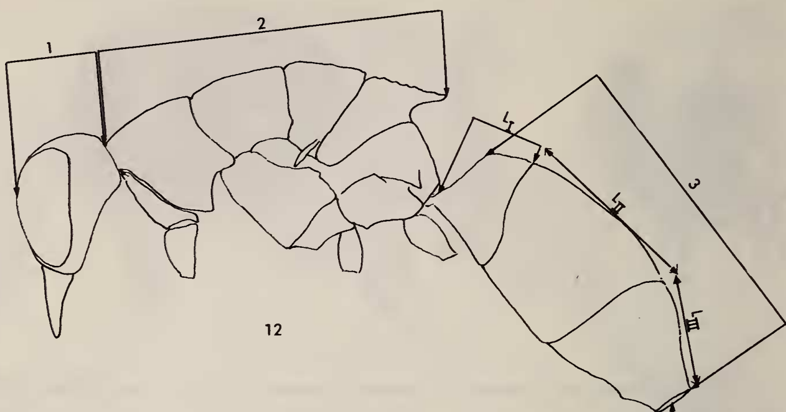


11

FIGURE 10. Diagram of head and antenna of *Elampus viridicyaneus* Norton (Hymenoptera, Chrysididae) showing measurements taken.

FIGURE 11. Diagram of forewing and hind wing of *Elampus* sp. (Hymenoptera, Chrysididae) showing measurements taken.



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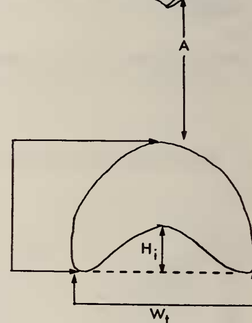
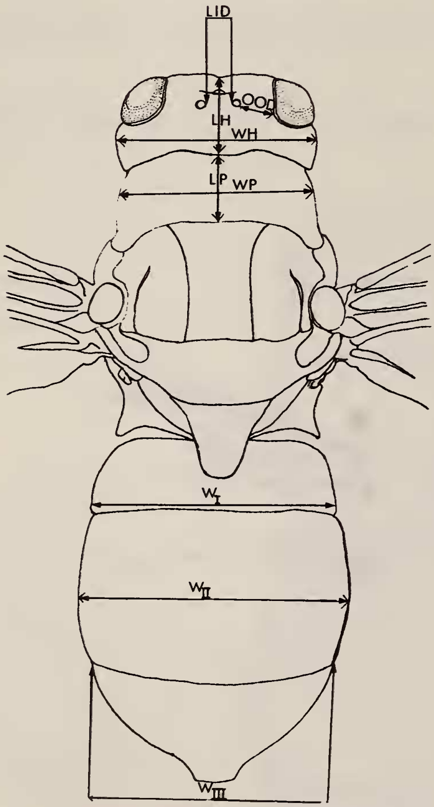


12a



13

FIGURE 12. Diagram of *Elampus* sp. (Hymenoptera, Chrysididae) showing measurements taken. Lateral view.

FIGURE 12a. Diagram of apical truncation of *Elampus* sp. showing measurements taken.

FIGURE 13. Diagram of *Elampus* sp. showing measurements taken. Dorsal view.

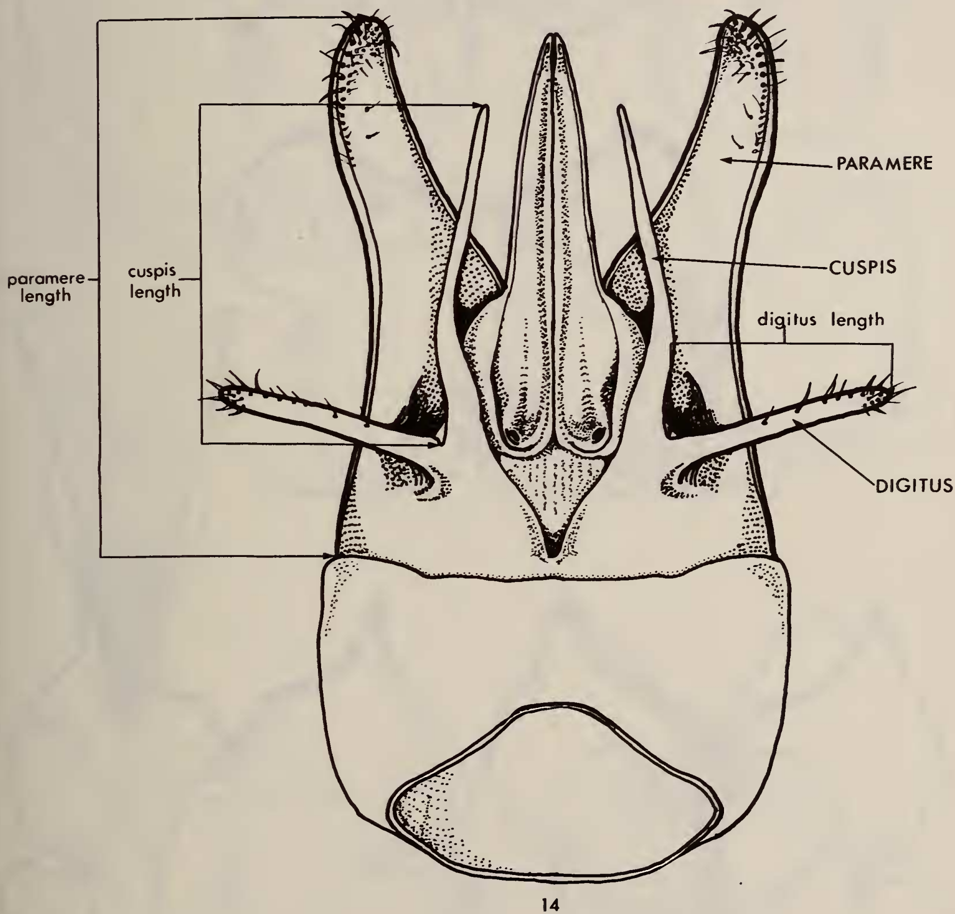
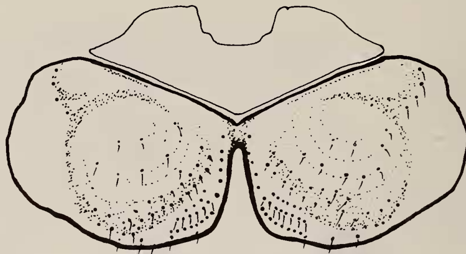


FIGURE 14. Drawing of male genitalia of *Elampus* sp. (Hymenoptera, Chrysididae) (from scanning electron microscope photograph).



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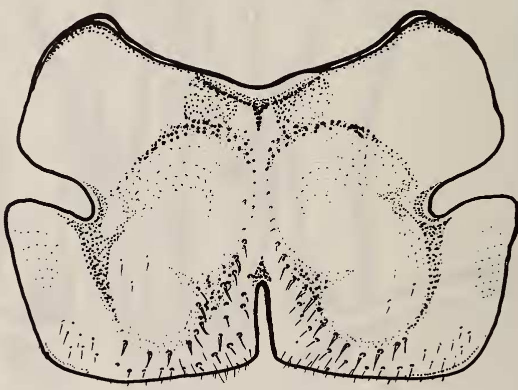

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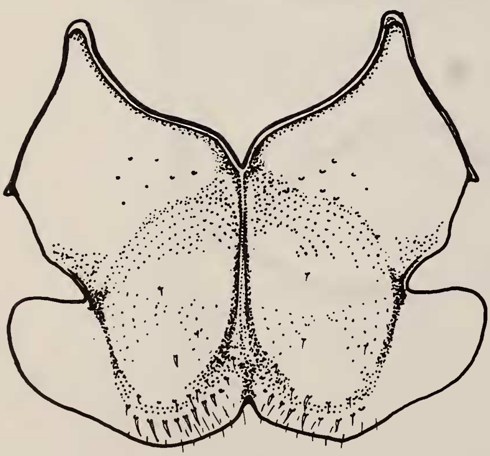

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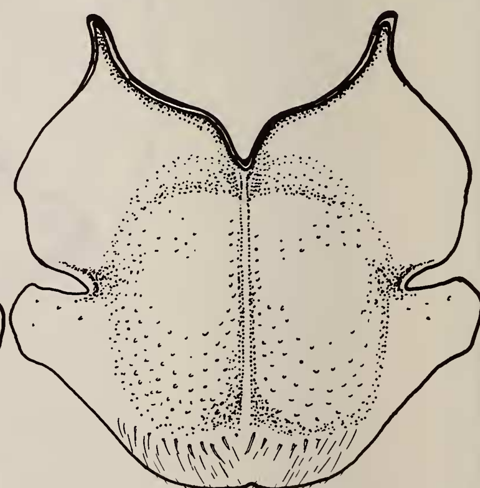

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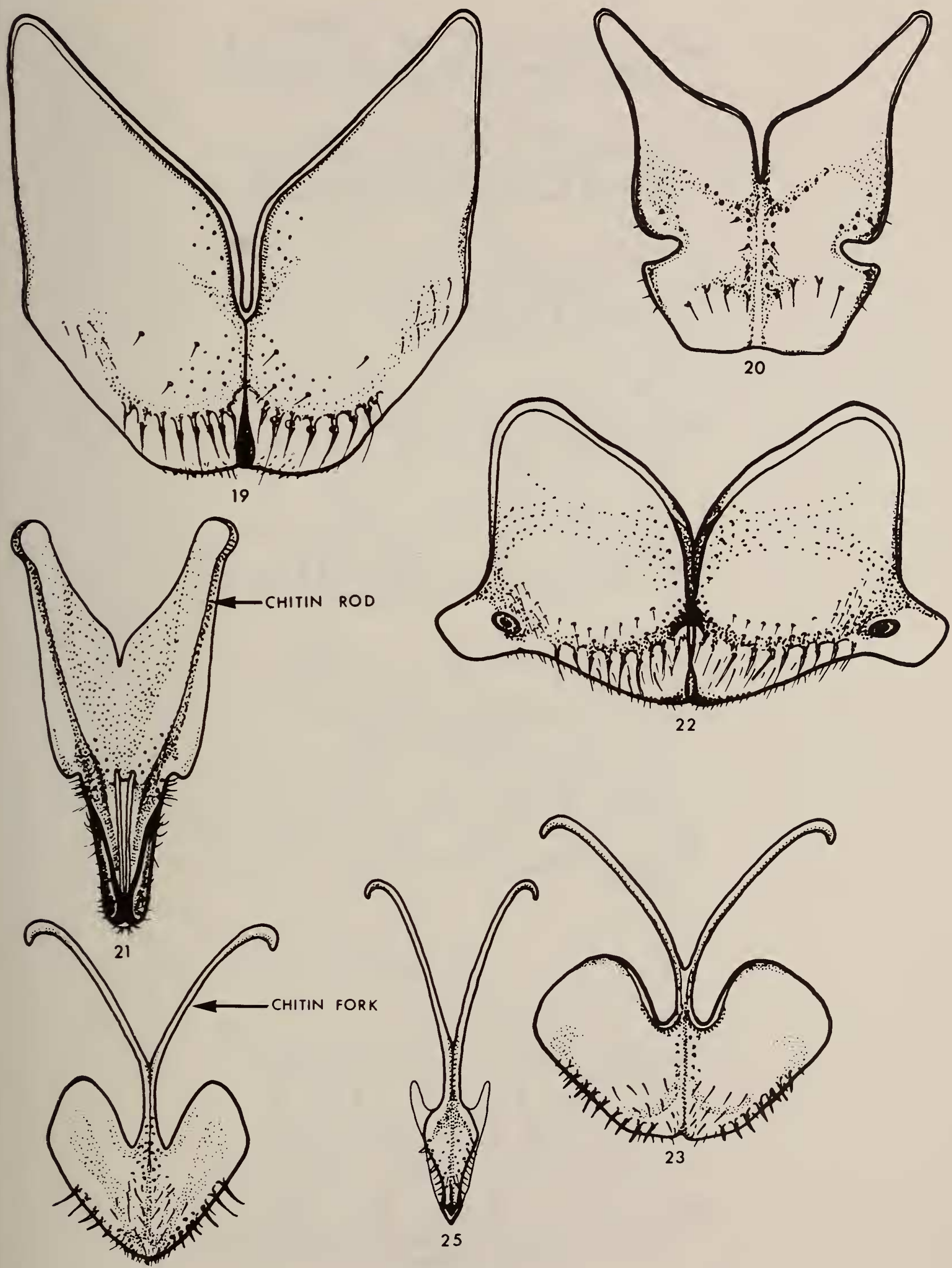
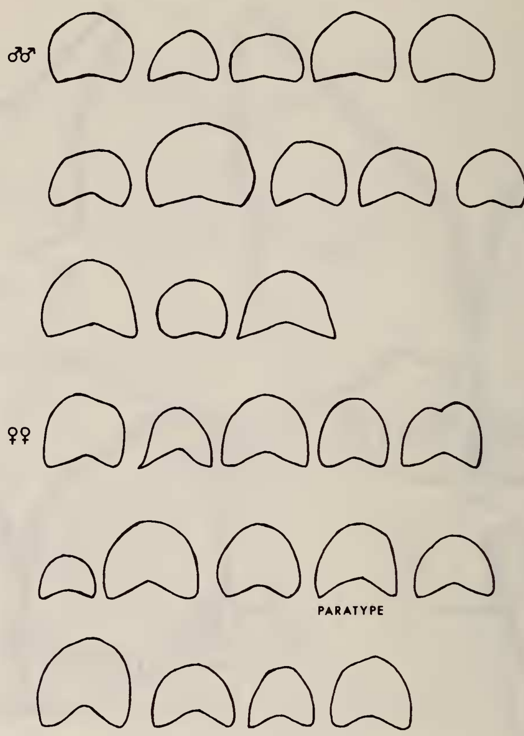
FIGURES 15-18. Visible sternites of *Elampus viridicyaneus* Norton ♀ (Hymenoptera, Chrysididae). Fig. 15, Sternite I. Fig. 16, Sternite II. Fig. 17, Sternite III. Fig. 18, Sternite III ♂.

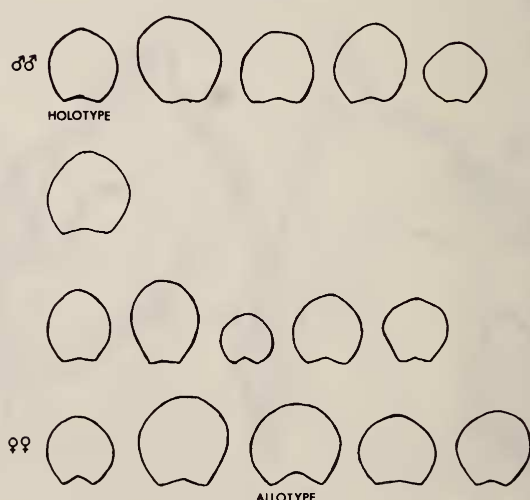


FIGURES 19-21. Hidden sternites of *Elampus viridicyaneus* Norton ♀ (Hymenoptera, Chrysididae). Fig. 19, Sternite IV. Fig. 20, Sternite V. Fig. 21, Sternite VI.

FIGURES 22-25. Hidden tergites of *Elampus viridicyaneus* Norton ♀ (Hymenoptera, Chrysididae). Fig. 22, Tergite IV. Fig. 23, Tergite V. Fig. 24, Tergite VI. Fig. 25, Tergite VII.



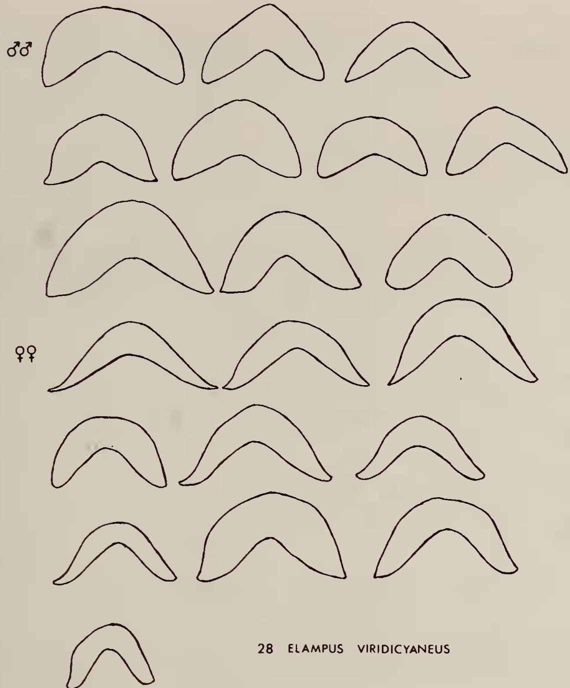
26 ELAMPUS HYALINUS

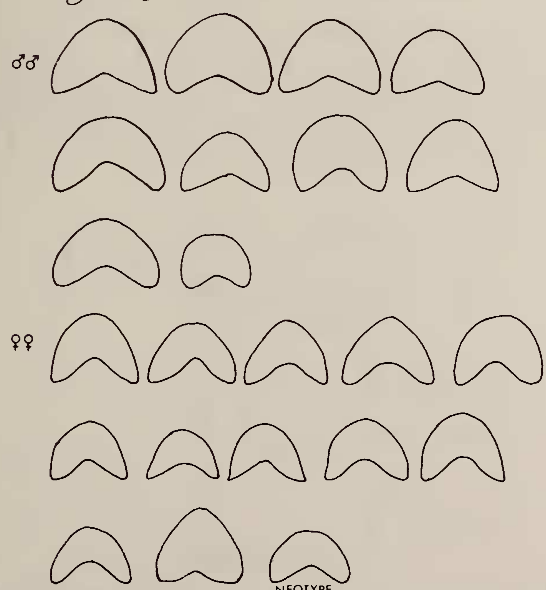


27 ELAMPUS ROTUNDUS

FIGURE 26. Variations in the shape of the apical truncation of *Elampus hyalinus* (Aaron) (Hymenoptera, Chrysididae).

FIGURE 27. Variations in the shape of the apical truncation of *Elampus rotundus* sp. nov. (Hymenoptera, Chrysididae).

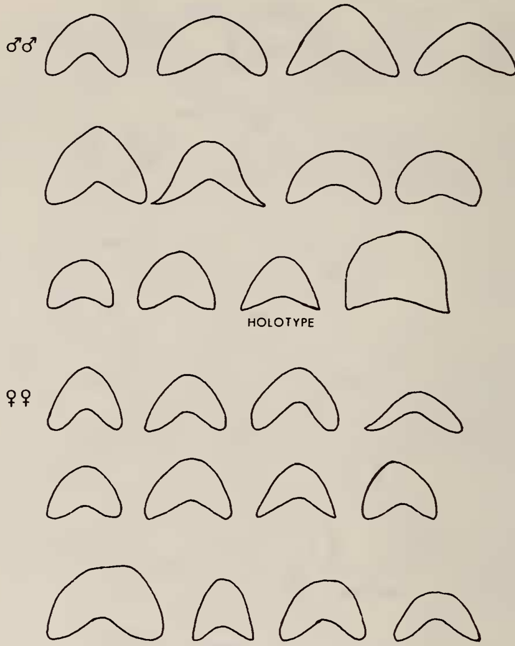




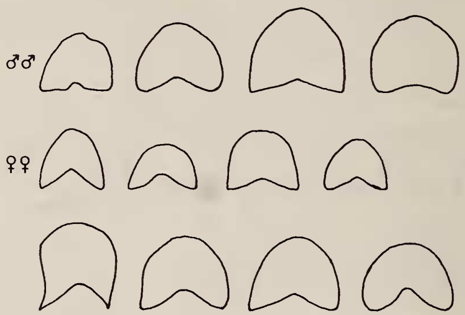
29 ELAMPUS MARGINATUS
(typical colour form)

FIGURE 28. Variations in the shape of the apical truncation of *Elampus viridicyaneus* Norton (Hymenoptera, Chrysididae).

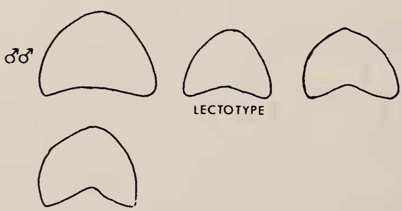
FIGURE 29. Variations in the shape of the apical truncation of *Elampus marginatus* (Patton) (typical form)(Hymenoptera, Chrysididae).



30 ELAMPUS NITIDUS



31 ELAMPUS NITIDUS



32 ELAMPUS MEXICANUS

FIGURE 30. Variations in the shape of the apical truncation of *Elampus nitidus nitidus* (Aaron) (Hymenoptera, Chrysididae) from Canada and U.S.A.

FIGURE 31. Variations in the shape of the apical truncation of *Elampus nitidus nitidus* (Aaron) (Hymenoptera, Chrysididae) from Mexico.

FIGURE 32. Variations in the shape of the apical truncation of *Elampus mexican*us Mocsáry (newly synonomized under *E. nitidus nitidus).*

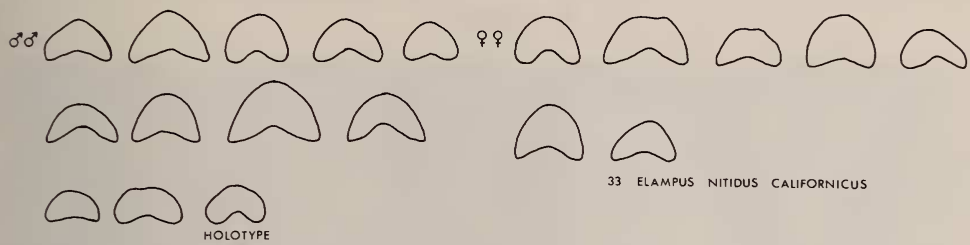


FIGURE 33. Variations in the shape of the apical truncation of *Elampus nitidus californicus* subsp. nov. (Hymenoptera, Chrysididae).

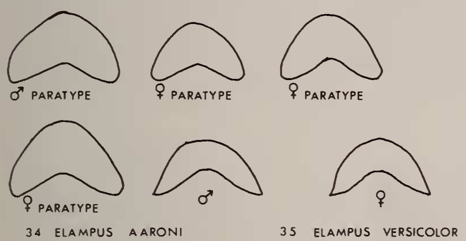
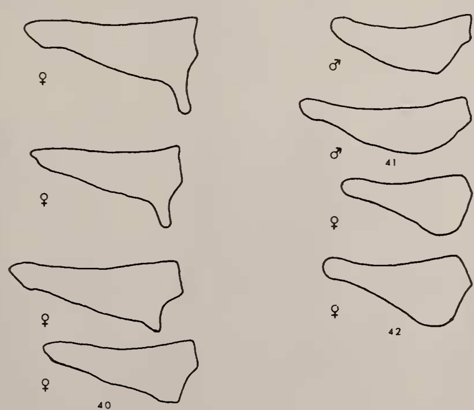


FIGURE 34. Variations in the shape of the apical truncation of *Elampus aaroni* Bodenstein.

FIGURE 35. Shape of apical truncation of *Elampus versicolor* from Florissant, Colorado.

FIGURES 36-39. Variations in the shape of the tarsal claws of *Elampus* spp. (Hymenoptera, Chrysididae). Fig. 36, *Elampus rotundus* sp. nov. Fig. 37, *Elampus marginatus* (Patton). Fig. 38, *Elampus viridicyaneus* Norton. Fig. 39, *Elampus hyalinus* (Aaron).



FIGURES 40-42. Variations in the shape of the fore femore of *Elampus* spp. (Hymenoptera, Chrysididae). Fig. 40, *Elampus marginatus* (Patton) (♀♀). Fig. 41, *Elampus marginatus* (Patton) (♂♂). Fig. 42, *Elampus hyalinus* (Aaron) (♀♀).

PLATE I

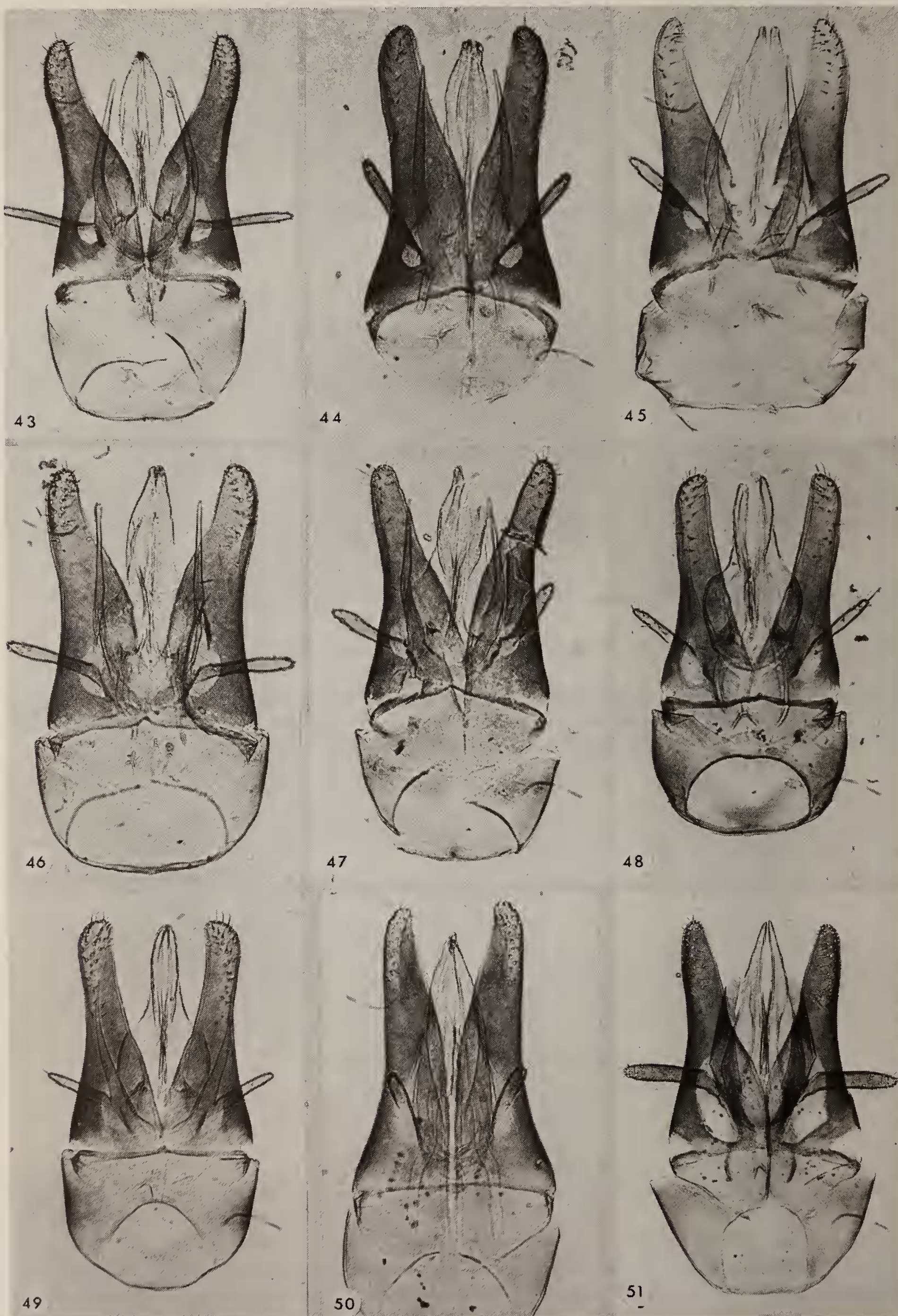


PLATE I

Male genitalia of *Elampus* spp. (43-50) and *Omalus seminudus* (Aaron) (51) (Hymenoptera, Chrysididae). Slide mounts.

43. *E. viridicyaneus* Norton.

44. *E. marginatus* (Patton).

45. *E. aaroni* Bodenstein.

46. E. *nitidus nitidus* (Aaron).

47. *E. nitidus californicus* subsp. nov.

48. *E. hyalinus* (Aaron).

49. *E. rotundus* sp. nov.

50. *E. gayi* Spinola.

51. *O. seminudus* (Aaron).

PLATE II

Elampus specimens (Hymenoptera, Chrysididae) coated with gold/palladium and photographed in an ETEC Autoscan microscope.

52. *Elampus marginatus* (Patton) ♀. Lateral view of gena and compound eye. About 112x.

53. *Elampus marginatus* (Patton) ♂ (ex. Midland, Ont.). Lateral view of gena and compound eye. About 87x.

54. *Elampus nitidus nitidus* (Aaron) (ex. Elbow, Sask.). Mandible and part of clypeus. About 68x.

55. *Elampus viridicyaneus* Norton (ex. Verdi, Nev.). Dorsal view of mesonotum. About 24x.

56. *Elampus viridicyaneus* Norton (ex. Varney, Ont.). Front view of face. About 29x.

57. *Elampus rotundus* sp. nov. (ex. Texas). Front view of face. About 63x.

PLATE II

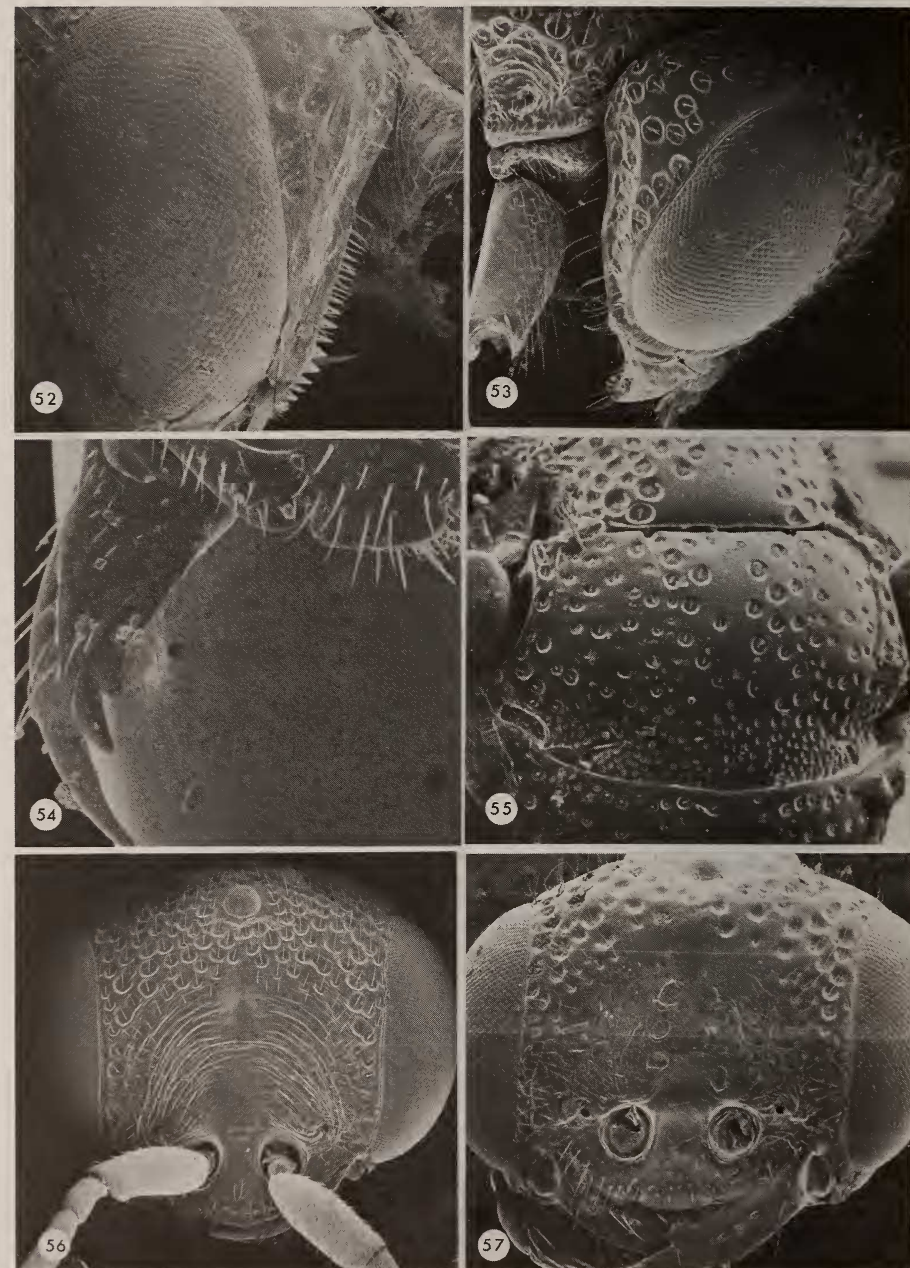


PLATE III

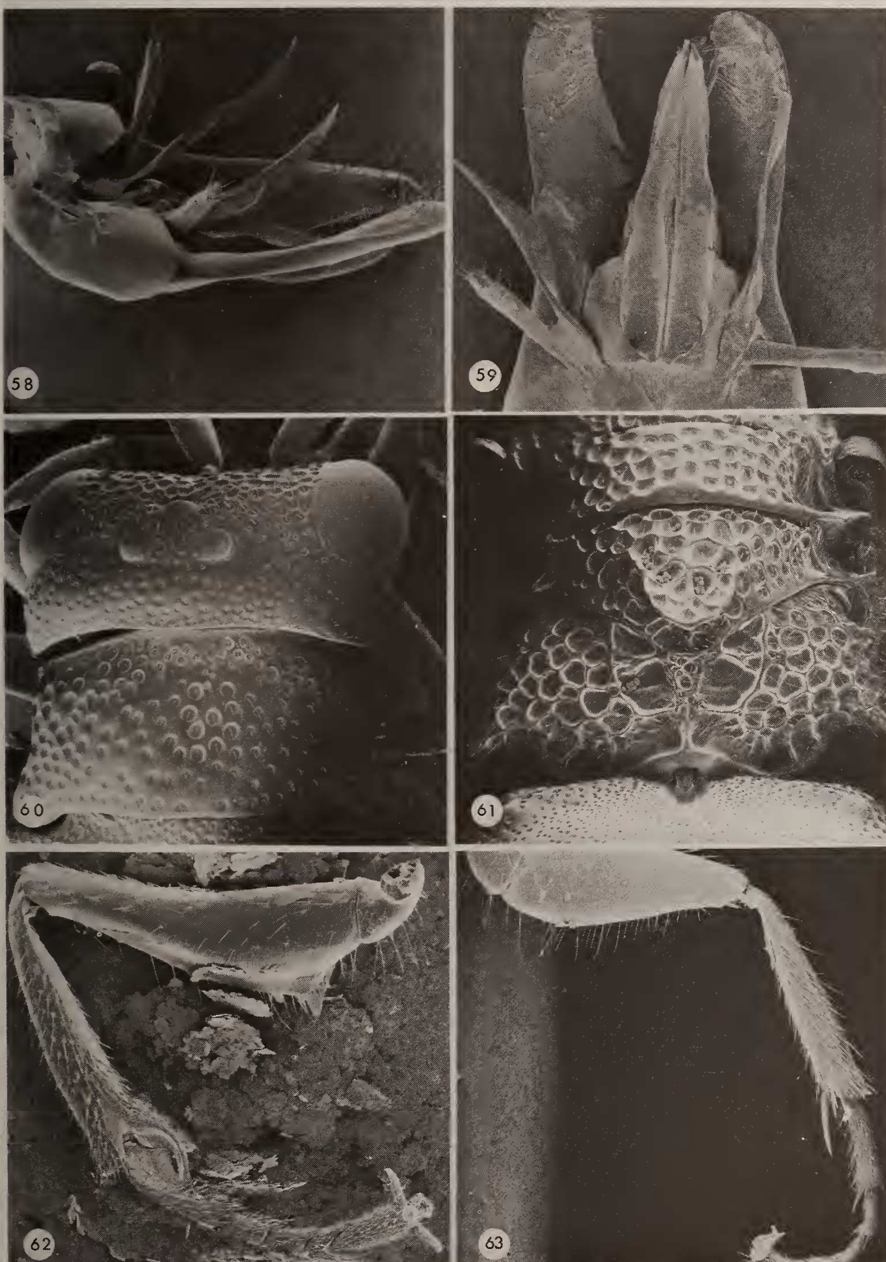


PLATE III

Elampus specimens (Hymenoptera, Chrysididae) coated with gold/palladium and photographed in an ETEC Autoscan microscope.

58. *Elampus viridicyaneus* Norton. Ventrolateral view of ♂ genitalia. About 47x.

59. *Elampus viridicyaneus* Norton. Ventral view of ♂ genitalia. About 47x.

60. *Elampus viridicyaneus* Norton (ex. Varney, Ont.). Dorsal view of head and pronotum. About 39x.

61. *Elampus viridicyaneus* Norton (ex. Varney, Ont.). Propodeum. About 17x.

62. *Elampus marginatus* (Patton) (ex. Midland, Ont.). Anterior view of right foreleg. About 68x.

63. *Elampus marginatus* (Patton) (ex. Midland, Ont.). Posterior view of right mid leg. About 62x.

PLATE IV

Elampus specimens (Hymenoptera, Chrysididae) coated with gold/palladium and photographed with an ETEC Autoscan microscope.

64. *Elampus marginatus* (Patton) (ex. Midland, Ont.). Posterior view of right hind leg. About 44x.

65. *Elampus viridicyaneus* Norton (ex. Varney, Ont.). Antenna. About 48x.

66. *Elampus viridicyaneus* Norton. Tarsal claw. About 227x.

67. *Elampus marginatus* (Patton). Tarsal claw. About 386x.

68. *Elampus hyalinus* (Aaron). Tarsal claw. About 483x.

69. *Elampus rotundus* sp. nov. Tarsal claw. About 483x.

PLATE V

Elampus specimens (Hymenoptera, Chrysididae) coated with gold/palladium and photographed in an ETEC Autoscan microscope.

70. *Elampus marginatus* (Patton) (ex. Midland, Ont.) ♂. Ventral view of abdomen. About 18x.

71. *Elampus hyalinus* (Aaron) (ex. Menlo, Kansas). Lateral view of abdomen. About 21x.

72. *Elampus marginatus* (Patton) (ex. Midland, Ont.). Lateral view of thorax. About 55x.

73. *Elampus viridicyaneus* Norton (ex. Varney, Ont.). Dorsal view of abdomen. About 14x.

74. *Elampus marginatus* (Patton) (ex. Midland, Ont.). Apical truncation of tergite III. About 32x.

75. *Elampus rotundus* sp. nov. (ex. Texas). Apical truncation of tergite III. About 37x.

PLATE IV

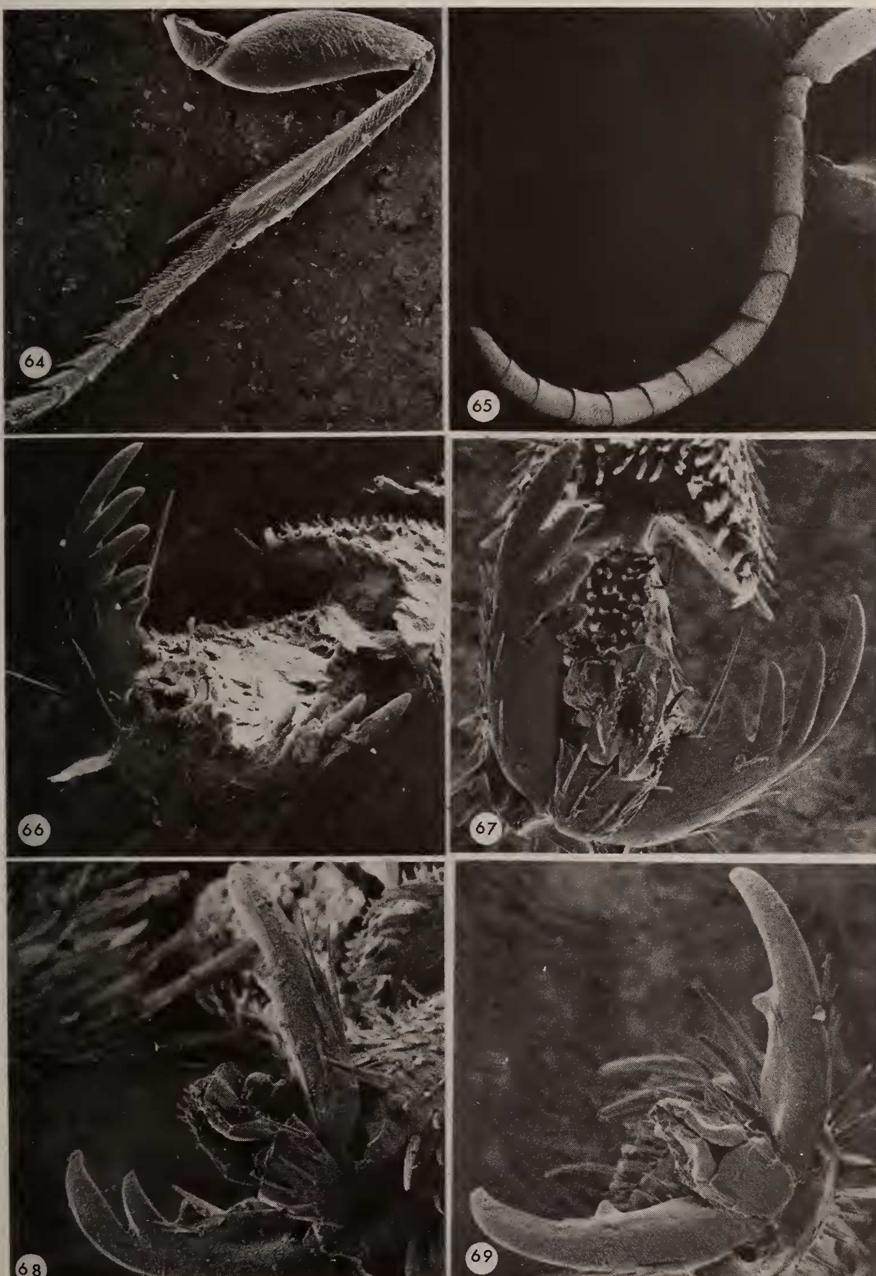
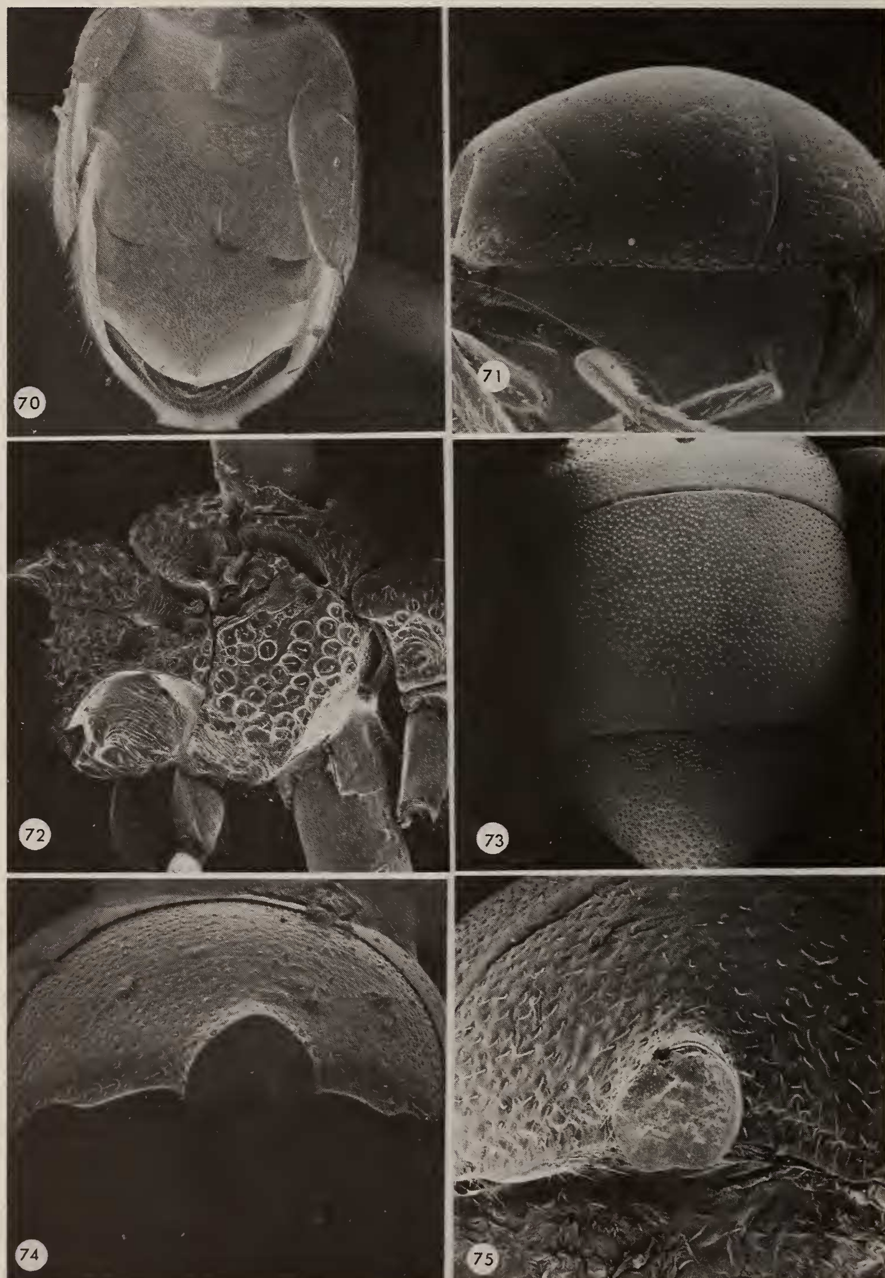


PLATE V



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